COKE

COKE.

By CHARLES E. MUNROE, Professor of Chemistry, George Washington University, Expert Special Agent.

As in previous censuses this report is limited to "oven coke," which is obtained from the dry distillation or imperfect combustion of bituminous coal in retorts, ovens, or pits. Ordinary gas-house coke, obtained as a by-product in the regular manufacture of illuminating gas, is not considered here, the statistics for its production being given under "manufactured gas." The statistics for petroleum coke are given under "petroleum refining." Although coke was manufactured in this country for some years prior to 1850, it was not included among manufactures until the census of that year. Separate returns have been received for this industry in each succeeding census, but as an analysis of the results recorded prior to 1880 seems to indicate that a considerable part of the product was lost in some other category, in this report the comparison of the results for different censuses begins with the census of 1880. That census covered the year ending May 31, 1880. The returns in each succeeding census were for the calendar year, excepting those for Michigan, in the census of 1905, which were for the year ending June 30, 1904.

The statistics are summarized in Table 1.

TABLE 1.—COMPARATIVE SUMMARY, AMOUNT AND PER CENT OF INCREASE: 1880 TO 1905.[1]

	CENSUS.				INCREASE.			PER CENT OF INCREASE.				
	1905	1900	1890	1880	1900 to 1905	1890 to 1905	1880 to 1905	1900 to 1905	1890 to 1905	1880 to 1905	1890 to 1900	1880 to 1890
Number of establishments	278	[2]241	218	126	37	60	152	15.4	27.5	120.6	10.6	73.0
Capital	$90,712,877	$36,502,679	$17,462,729	$4,769,858	$54,210,198	$73,250,148	$85,943,019	148.5	419.5	1,801.8	109.0	266.1
Salaried officials, clerks, etc., number	1,386	915	161	.....	471	1,225	.....	51.5	760.9	.....	468.3	.....
Salaries	$1,247,502	$797,296	$113,632	.....	$450,206	$1,133,870	.....	56.5	997.8	.....	601.6	.....
Wage-earners, average number	18,981	16,999	8,998	3,140	1,982	9,983	15,841	11.7	110.9	504.5	88.9	186.6
Total wages	$9,304,498	$7,085,736	$4,072,632	$1,197,744	$2,218,762	$5,231,866	$8,106,754	31.3	128.5	676.8	74.0	240.0
Men 16 years and over	18,915	16,932	8,942	.....	1,983	9,973	.....	11.7	111.5	.....	89.4	.....
Wages	$9,290,216	$7,071,834	$4,064,118	.....	$2,218,382	$5,226,098	.....	31.4	128.6	.....	74.0	.....
Children under 16 years	66	67	56	.....	[3]1	10	.....	[3]1.5	17.9	.....	19.6	.....
Wages	$14,282	$13,902	$8,514	.....	$380	$5,768	.....	2.7	67.7	.....	63.3	.....
Miscellaneous expenses	$4,891,130	$2,184,968	$394,784	[4]	$2,706,162	$4,496,346	.....	123.9	1,138.9	.....	453.5	.....
Materials used, total cost	$29,884,532	$19,665,532	$11,509,737	$2,995,441	$10,219,000	$18,374,795	$26,889,091	52.0	159.6	897.7	70.9	284.2
Coal:												
Short tons	33,781,006	30,157,829	15,795,087	4,360,110	6,623,177	20,985,919	32,420,896	22.0	132.9	743.6	90.9	262.3
Cost	$28,360,121	$18,355,252	$11,110,700	$2,761,657	$10,004,869	$17,249,421	$25,598,464	54.5	155.3	926.9	65.2	302.3
All other materials	$1,524,411	$1,310,280	$399,037	$233,784	$214,131	$1,125,374	$1,290,627	16.3	282.0	552.1	228.3	70.7
Products, total value	$51,728,647	$35,585,445	$16,498,345	$5,359,489	$16,143,202	$35,230,302	$46,369,158	45.4	213.5	865.2	115.7	207.8
Coke:												
Short tons	24,733,063	19,640,798	10,008,169	2,752,475	5,092,265	14,724,894	21,980,588	25.9	147.1	798.6	96.2	263.6
Value	$49,002,051	$34,633,418	$16,494,454	$5,359,489	$14,368,633	$32,507,597	$43,642,562	41.5	197.1	814.3	110.0	207.8
All other products	$2,726,596	$952,027	$3,891	.....	$1,774,569	$2,722,705	.....	186.4	69,974.4	.....	24,367.4	.....

[1] Exclusive of the statistics of establishments making coke, but engaged primarily in the manufacture of other products; in 1905 the 17 establishments of this class produced 410,225 short tons of coke valued at $1 302,572.
[2] Not including 1 penal institution.
[3] Decrease.
[4] Not reported.

Table 1 embraces the principal statistics of the coke manufacturing industry at the censuses from 1880 to 1905, inclusive, and sets forth the percentage of increase in each item for each of the three periods treated. This table gives only the statistics of active establishments engaged primarily in the manufacture of coke. By capital is meant only that which is represented by the value of lands, buildings, ovens, machinery, tools, and implements, and the quick capital required to carry on the business. The term, as here used, does not include the capital stock of any of the corporations.

Table 2 presents, by states and territories, the number of coke establishments, including establishments engaged primarily in the manufacture of other products, in active operation in 1880, 1890, 1900, and 1905.

TABLE 2.—*Number of active establishments, by states and territories: 1880 to 1905.*

STATE OR TERRITORY.	1905	1900	1890	1880
United States	[1] 295	[2] 241	218	126
Alabama	24	15	19	3
Colorado	13	9	7	1
Georgia	2	2	1	1
Illinois	1	1	2	1
Indian Territory	4	2	1	.....
Indiana	.....	1	3	1
Kansas	4	8	6	.....
Kentucky	7	5	5	.....
Maryland	1	.....	.....	.....
Massachusetts	1	1	.....	.....
Michigan	1	.....	.....	.....
Minnesota	1	.....	.....	.....
Missouri	.....	3	3	.....
Montana	2	2	2	.....
New Jersey	1	.....	.....	.....
New Mexico	2	2	.....	.....
New York	3	1	.....	.....
Ohio	6	5	13	15
Pennsylvania	112	89	98	89
Tennessee	9	8	8	4
Utah	2	1	1	.....
Virginia	13	5	2	.....
Washington	3	2	1	.....
West Virginia	80	77	45	11
Wisconsin	2	1	1	.....
Wyoming	1	1	.....	.....

[1] Includes 17 establishments engaged primarily in the manufacture of products other than coke.
[2] Not including 1 penal institution.

The Bureau of the Census classifies each establishment according to that one of its products which has the maximum value, and includes its other products in the classification. In order to obtain a complete idea of the magnitude and character of a given industry, such as the one now under consideration, it is necessary, therefore, that all the data relating to it should be brought together from all classifications. Additional establishments which produce coke have been included in Table 2 and the combined statistics have been incorporated in some minor tables. The number of these plants producing coke as a minor product at the census of 1905 was 17, of which 4 operated by-product ovens and 13 operated beehive ovens. They produced 410,225 tons of coke, valued at $1,302,572; by-products, valued at $423,385; and "all other products," valued at $504.

The number of coke producing states and territories has steadily increased from 9 states in 1880 to 17 states and 1 territory in 1890, 20 states and 2 territories in 1900, and 22 states and 2 territories in 1905. Comparing the states and territories reporting active establishments in 1905 with states and territories reporting a production of bituminous coal in 1902,[1] it is found that coke was produced in 5 states which do not produce bituminous coal, and that 11 states and territories producing bituminous coal did not report the production of coke. Four states, namely, Maryland, Michigan, Minnesota, and New Jersey, have been added to the list of coke producing states since 1900. Twelve states and 1 territory show an increase in the number of establishments. Kansas shows a decrease in the number of establishments, while Indiana and Missouri, which had, respectively, 1 and 3 active establishments in 1900, show no production in 1905. In Illinois and Indiana the production was less in 1900 than in 1890; but in Alabama, Pennsylvania, and Ohio, while the number of establishments was smaller in 1900 than in 1890, the production increased, showing the effect of consolidation and the abandonment of ovens operated on a small scale.

Table 3 gives a comparative summary of the ovens and capital of both active and idle establishments, with amount and per cent of increase, for 1890, 1900, and 1905, only those establishments engaged primarily in the production of coke being considered. No special effort was made in the present census to secure returns from idle establishments, and the statistics for such establishments should not, therefore, be regarded as complete.

[1] Bureau of the Census, Mines and Quarries, 1902, page 680.

TABLE 3.—CAPITAL—ACTIVE AND IDLE ESTABLISHMENTS: 1890 TO 1905.

	CENSUS.						ACTIVE ESTABLISHMENTS.				
	1905		1900		1890		Increase.		Per cent of increase.		
	Active.	Idle.	Active.	Idle.	Active.	Idle.	1900 to 1905	1890 to 1905	1900 to 1905	1890 to 1905	1890 to 1900
Number of establishments	278	29	[1] 241	14	218	28	37	60	15.4	27.5	10.6
Ovens, number	[2] 61,611	3,672	47,142	669	32,659	1,247	14,469	28,952	30.7	88.6	44.3
Capital	$90,712,877	$2,703,149	$36,502,679	$511,669	$17,402,729	$444,483	$54,210,198	$73,250,148	148.5	419.5	106.0
Land	$8,374,672	$577,965	$2,927,354	$13,950	$1,405,342	$6,425	$5,447,318	$6,969,330	186.1	495.9	108.3
Buildings	$14,235,683	$136,818	$2,382,237	$62,800	$869,725	$48,723	$11,853,446	$13,365,958	497.6	1,536.8	173.9
Ovens	$50,862,467	$875,377	$18,351,924	$303,469	$10,817,624	$312,661	$32,510,543	$40,044,843	177.2	370.2	69.6
Machinery, tools, and implements	$8,703,863	$421,755	$5,027,702	$131,450	$823,790	$44,791	$2,776,161	$7,880,073	46.8	956.6	510.6
Cash and sundries	$8,536,192	$691,234	$6,913,462	.....	$3,546,248	$31,883	$1,622,730	$4,989,944	23.5	140.7	95.0

[1] Not including 1 penal institution.
[2] Does not include 17 establishments, operating 1,362 ovens, engaged primarily in the manufacture of products other than coke.

From the returns it appears that the total number of establishments, both active and idle, engaged primarily in the production of coke in 1905 was 307; in 1900, 255; and in 1890, 246. The number in 1905, therefore, showed a gain of 52, or 20.4 per cent, over 1900, and of 61, or 24.8 per cent, over 1890. The total number of ovens in these establishments in 1905 was 65,283; in 1900, 47,811; and in 1890, 33,906. Ovens, therefore, increased in number in 1905, 17,472, or 36.5 per cent, over 1900, and 31,377, or 92.5 per cent, over 1890.

The percentage of idle ovens to total ovens was 5.6 in 1905, 1.4 in 1900, and 3.7 in 1890.

The total capital was $93,416,026 in 1905, $37,014,348 in 1900, and $17,907,212 in 1890. The amount of capital invested in 1905 increased $56,401,678, or 152.4 per cent, over 1900, and $75,508,814, or 421.7 per cent, over 1890. The capital invested in idle plants represented 2.9 per cent of the total capital in 1905, 1.4 per cent in 1900, and 2.5 per cent in 1890. In 1905 the percentage of the total capital invested in land was 9.6; in buildings, 15.4; in ovens, 55.4; in machinery, tools, and implements, 9.7; and in cash and sundries, 9.9. In 1900 the percentage of total capital invested in land was 7.9; in buildings, 6.6; in ovens, 50.4; in machinery, tools, and implements, 16.4; and in cash and sundries, 18.7. In 1890 the percentage of total capital invested in land was 7.9; in buildings, 5.1; in ovens, 62.2; in machinery, tools, and implements, 4.8; and in cash and sundries, 20.

Table 4 shows the amount and cost of the coal charged into the ovens in 1880, 1890, 1900, and 1905, respectively, by states and territories, with the per-centage of increase or decrease in quantity and in cost for each intervening decade.

TABLE 4.—QUANTITY AND VALUE OF COAL USED, WITH PER CENT OF INCREASE, BY STATES AND TERRITORIES: 1880 TO 1905.

STATE OR TERRITORY.	COAL CONSUMED.								PER CENT OF INCREASE.					
	1905		1900		1890		1880		1900 to 1905		1890 to 1900		1880 to 1890	
	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Short tons.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
United States	[1] 37,376,251	[1] $29,559,104	30,157,829	$18,355,252	15,795,087	$11,110,700	4,360,110	$2,761,657	23.9	61.0	90.9	65.2	262.3	302.3
Alabama	4,027,656	3,799,827	3,028,472	2,596,718	1,789,047	1,755,876	67,376	75,314	33.0	46.3	69.3	47.9	2,555.3	2,231.4
Colorado	1,000,206	922,394	817,725	496,033	323,731	399,778	29,500	29,500	22.3	85.9	152.6	24.1	997.4	1,255.2
Indian Territory	126,627	130,049												
Indiana													995.2	697.8
Kansas	14,107	20,084	26,988	26,079	16,428	16,156	1,500	2,025	[2] 47.7	[2] 23.0	24.9	189.4		
Kentucky	[4] 127,511	56,923	151,503	72,196	21,600	9,011								
Missouri			5,320	2,256	25,192	13,542								
Ohio	203,032	342,574	142,678	102,540	8,485	3,118			[2] 15.8	[2] 21.2	501.4	433.1		
Pennsylvania	23,128,917	14,524,648	19,490,030	10,899,832	134,178	123,992	193,848	228,432	42.3	234.1	[2] 37.3	[2] 27.6		
Tennessee	573,629	582,461	684,821	501,927	11,336,985	6,992,573	3,605,095	2,031,305	18.7	33.3	6.3	[2] 17.3	[2] 30.8	[2] 45.7
Virginia	1,676,256	1,105,432	994,635	523,979	619,016	523,400	179,311	124,137	[2] 16.2	16.0	71.9	55.9	214.2	244.2
West Virginia	3,746,602	2,676,652	3,792,825	1,874,960	1,025,885	686,570	148,480	135,944	68.5	110.0	10.6	[2] 4.1	245.2	321.6
All other states	[3] 2,751,708	5,398,060	[4] 1,022,832	1,258,732	[5] 494,540	586,684	[6] 132,000	135,000	[2] 1.2	42.8	269.7	173.1	590.9	405.0
									169.0	328.8	106.8	114.6	274.7	334.6

[1] Includes 595,245 short tons, valued at $1,198,983, used for the manufacture of coke in establishments engaged primarily in the manufacture of other products.
[2] Decrease.
[3] Includes Georgia, Illinois, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New Mexico, New York, Utah, Washington, Wisconsin, and Wyoming.
[4] Includes Georgia, Illinois, Indian Territory, Indiana, Massachusetts, Montana, New Mexico, New York, Utah, Washington, Wisconsin, and Wyoming.
[5] Includes Georgia, Illinois, Indian Territory, Montana, Utah, Virginia, Washington, and Wisconsin.
[6] Includes Georgia and Illinois.

Bituminous coal is the only raw material used in this industry and its cost, as charged into the ovens, is the principal item of expense. For Census purposes the cost of the coal consumed, whether mined in the immediate vicinity or transported from a distance, is its cost at the ovens, and all expenses of mining or of preparing the coal, such as crushing or washing, and of transportation to the ovens, is included in this cost. In the Census Report on Coke for 1900, after noting that the amount of coal used had increased 90.9 per cent, while its cost had increased only 65.2 per cent for the decade 1890 to 1900, it was stated: "This difference has been due in great part to improvements in mining machinery and methods, and in underground haulage, which have decreased the cost of production."[1]

[1] Twelfth Census, Manufactures, Part IV, page 694.

Judging from Table 4, such improvements have made no marked advance during the past five years. It further appears that the average cost per ton of coal consumed in making coke in the United States in 1905 was $0.79; in 1900, $0.61; in 1890, $0.70; and in 1880, $0.63. The average cost of coal consumed in making coke in the various states and territories in 1905 was Alabama, $0.94; Colorado, $0.92; Indian Territory, $1.03; Kansas, $1.42; Kentucky, $0.45; Ohio, $1.69; Pennsylvania, $0.63; Tennessee, $1.02; Virginia, $0.66; West Virginia, $0.71; and in "all other states," $1.96.

Table 5 presents a statement of the condition of the coal when charged into the coking ovens—that is, whether it was run of mine, or slack, and whether it was washed or unwashed; but it does not set forth any information as to the crushing of the coal, a practice which obtains in certain establishments before coking.

TABLE 5.—QUANTITY AND COST OF DIFFERENT CLASSES OF COAL USED, WITH PER CENT OF INCREASE AND AVERAGE PRICE PER TON: 1890 TO 1905.

CLASS.	1905		1900		1890		PER CENT OF INCREASE.				AVERAGE PRICE PER SHORT TON.		
							1900 to 1905		1890 to 1900				
	Short tons.	Cost.	Short tons.	Cost.	Short tons.	Cost.	Quantity.	Cost.	Quantity.	Cost.	1905	1900	1890
Total	[1] 37,376,251	[1] $29,559,104	30,157,829	$18,355,252	15,795,087	$11,110,700	23.9	61.0	90.9	65.2	$0.79	$0.61	$0.70
Run of mine or lump, unwashed	25,165,692	17,663,115	20,844,637	12,309,681	11,631,436	8,255,542	20.7	43.5	79.2	49.1	0.70	0.59	0.71
Run of mine or lump, washed	2,902,721	3,885,787	1,457,961	1,304,437	421,074	305,983	99.1	197.9	246.2	326.3	1.34	0.89	0.73
Slack, unwashed	4,459,784	3,439,769	5,036,675	2,966,800	3,195,322	2,333,597	[2] 11.5	15.9	57.6	27.1	0.77	0.59	0.73
Slack, washed	4,848,054	4,570,433	2,818,556	1,774,334	547,255	215,578	72.0	157.6	415.0	723.1	0.94	0.63	0.39

[1] Includes 595,245 short tons, valued at $1,198,983, used in establishments engaged primarily in the manufacture of other products.
[2] Decrease.

From Table 5 it appears that of the coal used in the coke industry, the run of mine constituted 75.1 per cent in 1905, 74 per cent in 1900, and 76.3 per cent in 1890. Of this run of mine coal, the per cent washed was 10.3 in 1905, 6.5 in 1900, and 3.5 in 1890; while of the slack coal, the per cent washed was 52.1 in 1905, 35.9 in 1900, and 14.6 in 1890. In 1905 the total quantity of coal reported as washed was 7,750,775 short tons, in 1900 it was 4,276,517 short tons, and in 1890 it was 968,329 short tons. This was an increase of 81.2 per cent for 1905 over 1900 and 700.4 per cent over 1890. To present the data in another form, it may be said that of the total coal used, that washed formed 20.7 per cent in 1905, 14.2 per cent in 1900, and only 6.1 per cent in 1890.

Table 6 presents a statement of the amount and value of coke produced in the census years 1880 to 1905, inclusive; the amount and cost of coal used; the amount of coal, in pounds, necessary to produce a short ton of coke; and the value of the coal used to a ton of the coke produced.

TABLE 6.—*Comparative summary—relation of coal used to coke produced: 1880 to 1905.*

	1905	1900	1890	1880
Coal used:				
Short tons	[1] 37,376,251	30,157,829	15,795,087	4,360,110
Cost	$29,559,104	$18,355,252	$11,110,700	$2,761,657
Average cost per short ton	$0.79	$0.61	$0.70	$0.63
Coke made:				
Short tons	[2] 25,143,288	19,640,798	10,008,169	2,752,475
Value	$50,304,623	$34,633,418	$16,494,454	$5,359,489
Average value per short ton	$2.00	$1.76	$1.65	$1.95
Coal used per short ton of coke (pounds)	2,973	3,070	3,156	3,168
Average cost of coal to short ton of coke	$1.18	$0.93	$1.11	$1.00

[1] Includes 595,245 short tons, valued at $1,198,983, used in establishments engaged primarily in the manufacture of other products.
[2] Includes 410,225 short tons, valued at $1,302,572, made in establishments engaged primarily in the manufacture of other products.

The output of coke in 1905 was greater by 5,502,490 tons, or 28 per cent, than in 1900; by 15,135,119 tons, or 151.2 per cent, than in 1890; and by 22,390,813 tons, or 813.5 per cent, than in 1880. The value of the coke increased $15,671,205, or 45.2 per cent, in 1905 over 1900; $33,810,169, or 205 per cent, over 1890; and $44,945,134, or 838.6 per cent, over 1880. The average value per ton for coke in 1905 increased $0.24, or 13.6 per cent, over the value in 1900; $0.35, or 21.2 per cent, over that in 1890; and $0.05, or 2.6 per cent, over that in 1880. The amount of coal used in 1905 was 37,376,251 tons, yielding 25,143,288 tons of coke, which indicates a loss in weight caused by the coking process of 32.7 per cent. The value of the coal used was $29,559,104, and the value of the coke produced was $50,304,623, an increase of 70.2 per cent due to the process. In 1900 the coking process caused a decrease of 34.9 per cent in the weight of the coal and an increase of 88.7 per cent in its value, while in 1890 the corresponding figures were 36.6 per cent decrease in weight and 48.5 per cent increase in value, and in 1880 they were 36.9 and 94.1 per cent, respectively. The amount of coal necessary to make a hundred tons of coke was 148.7 tons in 1905, 153.5 tons in 1900, 157.8 tons in 1890, and 158.4 tons in 1880. The amount of coal necessary to produce a ton of coke continues to grow less, showing a continued increase in the efficiency of the coking operations.

Table 7 shows, by states and territories, the total amount of coal used and of coke produced in 1890, 1900, and 1905, together with the percentage of coal in coke in each state and territory at each of these censuses. By the yield of coal in coke is meant the percentage of the original weight of the coal that remains in the form of coke after the process of coking is complete.

TABLE 7.—QUANTITY AND PER CENT OF YIELD OF COAL IN COKE, BY STATES AND TERRITORIES: 1890 TO 1905.

STATE OR TERRITORY.	1905			1900			1890		
	Short tons of coal used.	Short tons of coke manufactured.	Per cent of yield in coke.	Short tons of coal used.	Short tons of coke manufactured.	Per cent of yield in coke.	Short tons of coal used.	Short tons of coke manufactured.	Per cent of yield in coke.
United States	[1] 37,376,251	[1] 25,143,288	67.3	30,157,829	19,640,798	65.1	15,795,087	10,008,169	63.4
Alabama	4,027,656	2,335,613	58.0	3,028,472	1,787,809	59.0	1,789,047	1,055,823	59.0
Colorado	1,090,206	585,662	58.6	817,725	503,543	61.6	323,731	199,638	61.7
Indian Territory	126,027	54,761	43.2						
Indiana							16,428	8,301	50.5
Kansas	14,107	9,091	64.4	26,988	14,476	53.6	21,600	13,910	64.4
Kentucky	127,511	63,092	49.5	151,503	81,095	53.5	25,192	13,021	51.7
Missouri				5,320	2,860	53.8	8,485	5,275	62.2
Ohio	203,032	120,631	59.4	142,678	83,878	58.8	134,178	75,826	56.5
Pennsylvania	23,128,917	16,308,934	70.5	19,490,030	13,245,594	68.0	11,336,985	7,372,653	65.0
Tennessee	573,629	324,451	56.6	684,821	380,525	55.6	619,016	356,964	57.7
Virginia	1,676,256	1,139,010	67.9	994,635	618,707	62.2			
West Virginia	3,746,602	2,355,146	62.9	3,792,825	2,278,679	60.1	1,025,885	612,645	59.7
All other states	[2] 2,751,708	1,846,897	67.1	[3] 1,022,832	643,632	62.9	[4] 494,540	294,113	59.5

[1] Includes 595,245 short tons of coal used and 410,225 short tons of coke made in establishments engaged primarily in the manufacture of other products.
[2] Includes Georgia, Illinois, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Jersey, New Mexico, New York, Utah, Washington, Wisconsin, and Wyoming.
[3] Includes Georgia, Illinois, Indian Territory, Indiana, Massachusetts, Montana, New Mexico, New York, Utah, Washington, Wisconsin, and Wyoming.
[4] Includes Georgia, Illinois, Indian Territory, Montana, Utah, Virginia, Washington, and Wisconsin.

The table shows that the yield of coal in coke in 1905 was 67.3 per cent as compared with 65.1 per cent in 1900 and 63.4 per cent in 1890. This increase in yield is accounted for partly by the introduction and increased use of by-product ovens, partly by improvements in the construction and operation of the beehive ovens, and partly by the preparation of the coal itself through washing or other treatment, prior to its being charged into the ovens. In 1905, of the 25,143,288 short tons of coke produced, 2,422,796 short tons, or 9.6 per cent, were produced in by-product ovens, while in 1900, of the 19,640,798 short tons produced, 906,534 short tons, or 4.6 per cent, were produced in by-product ovens. As stated above, no by-product coke was reported prior to 1900. The extent to which washing is practiced may be ascertained by an inspection of Table 5. From the analysis of the data in this table and Table 4, it appears that while the increase in the coal used in coking in 1905 is but 136.6 per cent over that for 1890, the increase in quantity of coal that was washed for use in coking in 1905 was 700.4 per cent over that of 1890.

The highest yield of coal in coke in each of the three census years was reported for Pennsylvania. The lowest yield in 1905 was in Indian Territory, 43.2 per cent; in 1900 it was in Kentucky, 53.5 per cent; and in 1890 it was in Indiana, 50.5 per cent. It must be stated in this connection, and the same statement should be made in regard to the amount of coal used in the manufacture of coke, that it is not possible to secure absolutely accurate information in regard to the yield of coal in coke for the reason that, in many instances, the coal is not weighed before being charged into the ovens, and therefore the amount as reported in the schedules is frequently estimated. The figures, however, may be taken as fairly representing the conditions.

For each state and territory in which there are at least 3 establishments, Table 8 gives for 1880, 1890, 1900, and 1905 the quantity of coke produced, the rank according to production, and the percentage which each makes of the total output for the United States. The statistics for the states and territories in each of which there are less than 3 establishments are combined in groups.

TABLE 8.—PRODUCTION OF COKE, BY STATES AND TERRITORIES, WITH RANK OF EACH: 1880 TO 1905.

STATE OR TERRITORY.	SHORT TONS OF COKE.				PER CENT OF TOTAL OUTPUT.				RANK.			
	1905	1900	1890	1880	1905	1900	1890	1880	1905 [1]	1900	1890	1880
United States	[2] 25,143,288	10,640,798	10,008,169	2,752,475	100.0	100.0	100.0	100.0	.....	.....	.....	.....
Pennsylvania	16,308,934	13,245,694	7,372,653	2,317,149	64.9	67.4	73.7	84.2	1	1	1	1
West Virginia	2,355,146	2,278,679	612,645	95,720	9.4	11.6	6.1	3.5	2	2	3	3
Alabama	2,335,613	1,787,809	1,055,823	42,035	9.3	9.1	10.5	1.5	3	3	2	6
Virginia	1,139,010	618,707	[3]	.....	4.5	3.2	[3]	.....	4	4	6	.....
Colorado	585,662	503,543	199,638	18,000	2.3	2.6	2.0	0.7	5	5	5	7
Tennessee	324,451	380,525	356,964	91,675	1.3	1.9	3.6	3.3	8	6	4	4
Ohio	120,131	83,878	75,826	109,206	0.5	0.4	0.8	4.0	14	8	8	2
Kentucky	63,092	81,095	13,021	.....	0.3	0.4	0.1	.....	16	9	12	.....
Indian Territory	54,761	24,339	[3]	.....	0.2	0.1	[3]	.....	17	17	15	.....
Kansas	9,091	14,476	13,910	.....	[4]	0.1	0.1	.....	22	10	11	.....
Missouri	.....	2,860	5,275	.....	.....	[4]	0.1	.....	.....	20	16	.....
Indiana	.....	2,105	8,301	1,000	.....	[4]	0.1	[4]	.....	21	14	9
Massachusetts	1,634,727	[3]	.....	.....	4.1	[3]	.....	.....	6	7	.....	.....
New York		[3]	.....	.....		[3]	.....	.....	10	15	.....	.....
New Jersey		.....	.....	.....		.....	.....	.....	15	.....	.....	.....
Maryland		.....	.....	.....		.....	.....	.....	7	.....	.....	.....
Georgia	489,405	[3]	[3]	[3]	1.9	[3]	[3]	[3]	13	11	7	5
Illinois		[3]	[3]	[3]		[3]	[3]	[3]	23	22	13	8
Minnesota		.....	.....	.....		.....	.....	.....	21	.....	.....	.....
Wisconsin		[3]	[3]	.....		[3]	[3]	.....	11	13	9	.....
Michigan		.....	.....	.....		.....	.....	.....	12	.....	.....	.....
Montana	322,705	[3]	[3]	.....	1.3	[3]	[3]	.....	20	10	10	.....
New Mexico		[3]	.....	.....		[3]	.....	.....	18	12	.....	.....
Utah		[3]	[3]	.....		[3]	[3]	.....	9	16	18	.....
Washington		[3]	[3]	.....		[3]	[3]	.....	19	14	17	.....
Wyoming		[3]	.....	.....		[3]	.....	.....	24	18	.....	.....
All other states	.....	[5] 617,188	[6] 294,113	[7] 77,600	.....	[5] 3.2	[6] 2.9	[7] 2.8	.....	.....	.....	.....

[1] Includes 17 subsidiary establishments.
[2] Includes 410,225 short tons made in establishments engaged primarily in the manufacture of other products.
[3] Included in "all other states."
[4] Less than one-tenth of 1 per cent.
[5] Includes Georgia, Illinois, Massachusetts, Montana, New Mexico, New York, Utah, Washington, Wisconsin, and Wyoming.
[6] Includes Georgia, Illinois, Indian Territory, Montana, Utah, Virginia, Washington, and Wisconsin.
[7] Includes Georgia and Illinois.

As in the past, the coke production of Pennsylvania in 1905 greatly exceeded that of any other state, but the margin is steadily decreasing, for whereas in 1880 the product of Pennsylvania constituted 84.2 per cent of the total, in 1890 it was 73.7 per cent, in 1900, 67.4 per cent, and in 1905 but 64.9 per cent. As in 1900, of the 6 leading coke producing states, 5, namely, Pennsylvania, West Virginia, Alabama, Virginia, and Tennessee, drew their coal supply from the coal fields of the Appalachian system, but whereas the proportion of the product coming from this field constituted in 1890, 92.5 per cent of the total and in 1900, 93.2 per cent, in 1905 it was but 89.4 per cent. In 1905 the coke producing states and territories west of the Mississippi, including Minnesota, yielded 4 per cent of the total output, and 6 states—Massachusetts, New York, New Jersey, Maryland, Minnesota, and Wisconsin—operating ovens at a distance from the coal fields, produced 4.9 per cent of the total. Massachusetts imported coal from abroad, but the major part of the supply for the other 5 states was drawn from the Appalachian fields. In 1905 the number of states each of which produced more than 100,000 tons of coke in the census year was 15, as compared with 7 in 1900, 5 in 1890, and 2 in 1880. Of the states which produced more than 100,000 tons each in 1905, 2—Colorado and Utah—are west of the Mississippi. In 1905 the total coke production was 28 per cent greater than in 1900, for there were 14 states each of which produced five-tenths of 1 per cent or more of the total production, while in 1900 there were but 6 states of which this was true. Considering the rank, Table 8 shows that there were 24 states and territories in which coke was produced in 1905, as compared with 22 in 1900, 18 in 1890, and 9 in 1880. At each census Pennsylvania has stood at the head of the coke producing states. West Virginia, Alabama, Virginia, and Colorado hold the second, third, fourth, and fifth places, respectively, in 1905, as they did at the census of 1900, while the first three occupied practically the same relative positions at the census of 1890. Massachusetts, which entered the list in 1900, taking the seventh place, passed to the sixth in 1905, while Maryland, which entered the list in 1905, took the seventh place. The most marked change in rank between the censuses of 1900 and 1905 is found in the case of Montana, which has passed from the tenth to the twentieth place. The most notable changes in rank between the censuses of 1880 and 1905 are to be observed in the cases of Indiana, which, though ninth in 1880, had ceased to produce in 1905; Illinois, which had dropped from the eighth to the twenty-third place; and Ohio, which had dropped from the second to the fourteenth place. It is of interest to note that Massachusetts, Maryland, New York, Wisconsin, and New Jersey, states in which by-product coke ovens are operated at

a distance from the bituminous coal deposits, took rank in the sixth, seventh, tenth, eleventh, and fifteenth places, respectively.

Table 9 gives a summary of the number of ovens in operation in 1880, 1890, 1900, and 1905, together with the amount of coal used, the amount and value of the coke produced, the average yield of coke in tons per oven, the average value per ton of coke at the ovens, and the percentage yield of the coal in coke.

TABLE 9.—OVENS OPERATED, QUANTITY AND VALUE OF COKE, AND YIELD OF COAL IN COKE: 1880 TO 1905.

	CENSUS.				PER CENT OF INCREASE.		
	1905	1900	1890	1880	1900 to 1905	1890 to 1900	1880 to 1890
Ovens, active, number	[1] 62,973	47,142	32,659	9,738	33.6	44.3	235.4
Coal used, short tons	[2] 37,376,251	30,157,829	15,795,087	4,360,110	23.9	90.9	262.3
Coke produced, short tons	[2] 25,143,288	19,640,798	10,608,169	2,752,475	28.0	85.2	285.6
Coke produced per oven, average yield, short tons	399	417	306	283	[3] 4.3	36.3	8.1
Yield of coal in coke, per cent	67.3	65.1	63.4	63.1			
Value of coke at ovens, total	[2] $50,304,623	$34,633,418	$16,494,454	$5,359,489	45.2	110.0	207.8
Per short ton	$2.00	$1.76	$1.65	$1.95	13.6	6.7	[3] 15.4

[1] Includes 1,362 ovens in 17 establishments engaged primarily in the manufacture of other products.
[2] Includes 595,245 short tons of coal and 410,225 short tons of coke, valued at $1,302,572, made in establishments engaged primarily in the manufacture of other products.
[3] Decrease.

Each item in Table 9, except the average yield of coke per oven, shows an increase for 1905 over the previous censuses. The decrease in the average yield of coke per oven is offset by the increase in the percentage yield of coal in coke. It should be noted that the total value of the coke and its average price per ton represent the value of the coke at the ovens before the expenses of transportation and marketing have been added.

Table 10 gives a comparative summary of the number and kinds of ovens in active operation, by states and territories, for 1890, 1900, and 1905.

TABLE 10.—*Comparative summary—number and kind of ovens in active use, by states and territories: 1890 to 1905.*

STATE OR TERRITORY.	Census.	OVENS.				
		Total number.	Beehive.	Belgian or flue.	By-product.	Other styles.
United States	1905	[1] 62,973	60,733	66	2,174	.....
	1900	47,142	45,680	.....	1,020	442
	1890	32,659	32,129	233	.....	297
Alabama	1905	5,247	5,007	.....	240	.....
	1900	5,206	4,872	.....	120	214
	1890	3,693	3,459	160	.....	74
Colorado	1905	2,250	2,208	42	.....	.....
	1900	1,221	1,185	.....	.....	36
	1890	872	672	.....	.....	200
Georgia	1905	451	451	.....	.....	.....
	1900	350	350	.....	.....	.....
	1890	(2)	.....	.....	.....	.....
Illinois	1905	24	.....	24	.....	.....
	1900	4	4	.....	.....	.....
	1890	(2)	.....	.....	.....	.....
Indian Territory	1905	286	286	.....	.....	.....
	1900	130	130	.....	.....	.....
	1890	(2)	.....	.....	.....	.....
Indiana	1905	.....	.....	.....	.....	.....
	1900	12	12	.....	.....	.....
	1890	102	102	.....	.....	.....
Kansas	1905	18	18	.....	.....	.....
	1900	86	86	.....	.....	.....
	1890	52	52	.....	.....	.....

[1] Includes 1,362 ovens—1,070 beehive and 292 by-product—operated by establishments engaged primarily in manufacturing products other than coke.

TABLE 10.—*Comparative summary—number and kind of ovens in active use, by states and territories: 1890 to 1905*—Continued.

STATE OR TERRITORY.	Census.	OVENS.				
		Total number.	Beehive.	Belgian or flue.	By-product.	Other styles.
Kentucky	1905	265	265	.....	.....	.....
	1900	290	290	.....	.....	.....
	1890	164	164	.....	.....	.....
Maryland	1905	180	.....	.....	180	.....
	1900	.....	.....	.....	.....	.....
	1890	.....	.....	.....	.....	.....
Massachusetts	1905	359	.....	.....	359	.....
	1900	400	.....	.....	400	.....
	1890	.....	.....	.....	.....	.....
Michigan	1905	120	.....	.....	120	.....
	1900	.....	.....	.....	.....	.....
	1890	.....	.....	.....	.....	.....
Minnesota	1905	50	.....	.....	50	.....
	1900	.....	.....	.....	.....	.....
	1890	.....	.....	.....	.....	.....
Missouri	1905	.....	.....	.....	.....	.....
	1900	12	12	.....	.....	.....
	1890	9	9	.....	.....	.....
Montana	1905	315	315	.....	.....	.....
	1900	203	203	.....	.....	.....
	1890	(2)	.....	.....	.....	.....
New Jersey	1905	100	.....	.....	100	.....
	1900	.....	.....	.....	.....	.....
	1890	.....	.....	.....	.....	.....
New Mexico	1905	284	284	.....	.....	.....
	1900	114	114	.....	.....	.....
	1890	.....	.....	.....	.....	.....
New York	1905	315	.....	.....	315	.....
	1900	25	.....	.....	25	.....
	1890	.....	.....	.....	.....	.....
Ohio	1905	331	251	.....	80	.....
	1900	235	235	.....	.....	.....
	1890	462	462	.....	.....	.....
Pennsylvania	1905	37,205	36,675	.....	530	.....
	1900	26,920	26,565	.....	355	.....
	1890	21,405	21,338	48	.....	19
Tennessee	1905	1,022	1,022	.....	.....	.....
	1900	1,727	1,727	.....	.....	.....
	1890	1,581	1,577	.....	.....	4
Utah	1905	504	504	.....	.....	.....
	1900	104	104	.....	.....	.....
	1890	(2)	.....	.....	.....	.....

[2] Included in "all other states and territories."

TABLE 10.—*Comparative summary—number and kind of ovens in active use, by states and territories: 1890 to 1905*—Continued.

STATE OR TERRITORY.	Census.	OVENS. Total number.	Beehive.	Belgian or flue.	By-product.	Other styles.
Virginia	1905	3,426	3,426	.....	.....	.....
	1900	1,588	1,528	.....	60	.....
	1890	(1)	.....	.....	.....	.....
Washington	1905	139	139	.....	.....	.....
	1900	90	90	.....	.....	.....
	1890	(1)	.....	.....	.....	.....
West Virginia	1905	9,910	9,790	.....	120	.....
	1900	8,231	7,979	.....	60	192
	1890	3,140	3,140	.....	.....	.....
Wisconsin	1905	152	72	.....	80	.....
	1900	120	120	.....	.....	.....
	1890	(1)	.....	.....	.....	.....
Wyoming	1905	20	20	.....	.....	.....
	1900	74	74	.....	.....	.....
	1890	.....	.....	.....	.....	.....
All other states and territories.	1905	.....	.....	.....	.....	.....
	1900	.....	.....	.....	.....	.....
	[2]1890	1,179	1,154	25	.....	.....

[1] Included in "all other states and territories."
[2] Includes Georgia, Illinois, Indian Territory, Montana, Utah, Virginia, Washington, and Wisconsin. Each state producing coke is reported separately for 1900 and 1905.

In comparing the number of establishments reported at different censuses it should be borne in mind that the method of reporting them differs from time to time with the changes in business organization. Separate plants reported as individual establishments at one census may have come under the same ownership during the period between censuses and be reported as a single establishment at a subsequent census. Such changes in the method of enumeration affects all details based upon the establishment as a unit of measurement.

In the United States the average number of ovens to an establishment increased from 196 in 1900 to 213 in 1905. In the three states that produce most of the coke the average number was: Pennsylvania, 332 in 1905 and 302 in 1900; West Virginia, 124 in 1905 and 107 in 1900; Alabama, 219 in 1905 and 347 in 1900. By far the greater portion of the coke manufactured in the United States is still made in the ordinary beehive ovens, of which there were 60,733 out of a total of 62,973 active ovens reported for 1905; 45,680 out of a total of 47,142 active ovens reported for 1900; and 32,129 out of a total of 32,659 active ovens reported for 1890. No coke has been reported as being produced in pits or mounds since 1890. In late years this method was employed merely in testing the value of coal for the production of coke, but the test is now made in a more satisfactory manner by shipping the coal to a properly constructed oven. The Belgian or flue ovens, reported separately in 1890 and 1905, were in 1900 included among "other styles." No by-product ovens were reported until 1900, when 1,020 ovens of this type, yielding 906,534 tons of coke, were enumerated. In 1905 there were reported 2,174 by-product ovens, yielding 2,422,796 tons of coke.

Table 11 presents the statistics relating to the capital and to the kind and the number of ovens in idle establishments, by states and territories, for 1890, 1900, and 1905.

TABLE 11.—*Comparative summary—capital and ovens in idle establishments, by states and territories: 1890 to 1905.*

STATE OR TERRITORY.	Census.	Number of establishments reporting.	Capital.	OVENS. Total number.	Beehive.	Belgian or flue.	Other styles.
United States	1905	29	$2,703,149	3,672	3,647	.....	25
	1900	14	511,669	669	665	.....	4
	1890	28	444,483	1,247	1,142	65	40
Alabama	1905	6	239,196	1,555	1,555	.....	.....
	1900	1	20,000	90	90	.....	.....
	1890	1	19,000	76	76	.....	.....
Colorado	1905	1	8,000	21	21	.....	.....
	1900	3	17,900	22	18	.....	4
	1890	3	12,600	48	8	.....	40
Illinois	1905	.....	.....	.....	.....	.....	.....
	1900	2	83,700	126	126	.....	.....
	1890	1	50,000	102	102	.....	.....
Indiana	1905	.....	.....	.....	.....	.....	.....
	1900	.....	.....	.....	.....	.....	.....
	1890	1	1,800	9	9	.....	.....
Kansas	1905	.....	.....	.....	.....	.....	.....
	1900	.....	.....	.....	.....	.....	.....
	1890	1	5,136	16	16	.....	.....
Kentucky	1905	.....	.....	.....	.....	.....	.....
	1900	1	5,000	10	10	.....	.....
	1890	1	600	2	2	.....	.....
Montana	1905	.....	.....	.....	.....	.....	.....
	1900	1	244,000	100	100	.....	.....
	1890	.....	.....	.....	.....	.....	.....
New Mexico	1905	.....	.....	.....	.....	.....	.....
	1900	1	76,069	76	76	.....	.....
	1890	.....	.....	.....	.....	.....	.....
Ohio	1905	.....	.....	.....	.....	.....	.....
	1900	1	5,800	9	9	.....	.....
	1890	.....	.....	.....	.....	.....	.....
Pennsylvania	1905	8	1,345,845	366	341	.....	25
	1900	4	59,200	236	236	.....	.....
	1890	15	317,297	884	819	65	.....
Tennessee	1905	2	71,705	245	245	.....	.....
	1900	.....	.....	.....	.....	.....	.....
	1890	2	16,050	58	58	.....	.....
Washington	1905	1	50,000	25	25	.....	.....
	1900	.....	.....	.....	.....	.....	.....
	1890	.....	.....	.....	.....	.....	.....
West Virginia	1905	11	988,403	1,460	1,460	.....	.....
	1900	.....	.....	.....	.....	.....	.....
	1890	3	22,000	52	52	.....	.....

The capital invested in idle establishments has increased steadily in the three censuses for which the information has been gathered, it being $2,191,480, or 428.3 per cent, greater in 1905 than in 1900, and $2,258,666, or 508.2 per cent, greater in 1905 than in 1890. The percentage of capital invested in idle establishments of that invested in active establishments was 3 in 1905, 1.4 in 1900, and 2.5 in 1890. The total capital invested in idle establishments in 1905 was divided among the states as follows: Pennsylvania, 49.8 per cent; West Virginia, 36.6 per cent; Alabama, 8.8 per cent; Tennessee, 2.7 per cent; Washington, 1.8 per cent; and Colorado three-tenths of 1 per cent. While the capital invested in idle establishments has constantly increased, the number of idle ovens has fluctuated. In 1905 the number of idle establishments was 15, or 107.1 per cent, greater than in 1900,

and the number of idle ovens in 1905 was 3,003, or 448.9 per cent, greater than in 1900. Table 11 shows that the idle ovens were principally of the beehive type, and that the largest number of idle establishments and idle ovens were located in West Virginia, though the largest investment was in Pennsylvania. This was due to the fact that a portion of the ovens idle in Pennsylvania were of the by-product type.

BY-PRODUCTS.

Table 12 shows the quantity and value of the by-products obtained from retort or by-product ovens in 1900 and 1905, enumerating the more important of these.

TABLE 12.—*By-products: 1905 and 1900.*

	Unit of measure.	1905		1900	
		Number.	Value.	Number.	Value.
Total value			$3,147,288		$952,027
Tar	Gallons	26,223,323	613,388	10,468,733	207,952
Ammonium sulphate.	Pounds	31,546,781	818,290	11,984,931	330,921
Ammonia liquor	Gallons	4,791,468	763,291	1,572,325	180,642
Surplus gas sold	Thousand cubic feet.	4,463,062	843,787	1,171,943	225,022
Unclassified			108,532		7,490

The modern by-product oven, for the recovery on a commercial scale of the volatile bodies driven off from coal during the process of coking, was introduced in the United States in 1892, and the statistics of 1900 are therefore the first available for by-products. The by-products consist chiefly of tar; ammonia, obtained in the form of ammonium sulphate or as ammoniacal liquor; and surplus gas, which is sold for generating light, heat, and power.

The unclassified by-products consist of benzol, which is condensed and removed from that portion of the gas which is to be used as fuel in the ovens, pyridine, phenols, and other substances. The term "by-product" has a specific meaning in the coke industry. It is the general term by which those substances which were lost in the older processes of coking but which are recovered by the modern methods of coking are designated. Care should be taken that "by-products" should not be confused with "all other products," for this latter covers transactions in products like lumber, which are purely incidental to the carrying on of the coke industry. The value returned for these products in 1905 was $3,147,288, an increase over 1900 of $2,195,261, or 230.6 per cent. No attempt has been made in this investigation to ascertain the quantity and value of the products obtained from the coal tar, as in this industry tar is a final product. The quantity of gas produced was 20,695,371,300 cubic feet, of which 16,232,309,487 cubic feet were consumed in the process of carbonizing coal. No statistics are available from any previous census with which to compare this.

The total coal reported used in by-product ovens in 1905 was 3,317,585 tons. The number of cubic feet of gas produced per ton of coal used in by-product ovens was 6,238. In some instances, while the plants were under construction and before the by-product apparatus was available for use, the ovens were being operated to produce coke, and so gas and other volatiles were lost, and therefore the yield of gas per ton of coal as given above is lower than the possible yield. The total quantity of coal coked in 1905 was 37,376,251 tons, of which 3,317,585 tons, or 8.9 per cent, was coked in by-product ovens. The total quantity of coke produced in 1905 was 25,143,288 tons, of which 2,422,796 tons, or 9.6 per cent, was produced in by-product ovens. Of the 19,640,798 tons of coke produced in 1900, the by-product ovens made 906,534 tons, or 4.6 per cent. The coke produced in by-product ovens in 1905 was 1,516,262 tons, or 167.3 per cent, in excess of that produced in such ovens in 1900. The percentage yield of coal in coke in by-product ovens in 1905 was 73, while the yield of coal in coke for the total coal used in 1905 was 67.3.

The yield of tar per ton of coal used was 7.9 gallons, and its value $0.023 per gallon. The average yield of tar per ton of bituminous coal is usually accepted as 10 gallons. As tar is generally sold in barrels holding 50 gallons, the number of barrels reported was 524,466. The average weight of tar is 10 pounds per gallon, and the weight returned is therefore 262,233,000 pounds. These statistics for tar are subject to the same criticism that has been given above in regard to the data returned for gas.

The ammonia compounds obtained from the coal are reported in two forms. In the early practice of the destructive distillation of coal the ammonia compounds were recovered and disposed of as ammoniacal liquor, but to-day the practice at many of the by-product coke plants is to treat this liquor further so as to convert its ammonia contents into ammonium sulphate. It is desirable, in discussing the ammonium compounds produced, to reduce them to a common basis. Ammonium sulphate is to be preferred as a base for reference, as it is a definite substance of well-known composition, while the ammoniacal liquor is a variable mixture of many substances. In calling for the returns for "ammonia liquor," the "strength" was asked; and as returned it varied widely among the different establishments reporting. The data of each establishment were therefore reduced to terms of ammonium sulphate and the yield per ton of coal noted, and where the result varied from the limits fixed by Pennock,[1] they were inquired into specially. It was thus learned that the quantity of coal coked in by-product ovens from which the ammonia compounds were recovered was but 3,255,625 tons. The total

[1] V. Internationaler Kongress für angewandte Chemie, vol. 2, page 784.

quantity of ammonium compounds recovered, calculated as ammonium sulphate, was 62,633,417 pounds. This gives an average yield of 19.24 pounds of ammonium sulphate per ton of coal carbonized. Pennock gives the average as 20 pounds of ammonium sulphate per ton of coal. The average value of the ammonium sulphate reported was $0.026 per pound, and of the ammonia liquor, $0.159 per gallon.

It is possible from the statistics reported to calculate the quantity and value of the total products which might have been obtained if all of the coal which was coked in 1905 had been coked in by-product ovens, and such a presentation affords some idea of the loss which results from present practice.

Table 13 shows the quantity and value of all the products returned in 1905, with the percentage which the value of each product bears to the total value, the quantity of each product which would have been obtained if the entire 37,376,251 tons of coal had been coked in by-product ovens so that the volatiles were recovered, and the value of these products at the rate per unit which obtained in 1905.

TABLE 13.—ACTUAL QUANTITY AND VALUE OF ALL PRODUCTS REPORTED IN 1905, AND POSSIBLE QUANTITY AND VALUE OF PRODUCTS IF TOTAL COAL HAD BEEN TREATED IN BY-PRODUCT OVENS.

	Unit of measure.	ACTUAL.			POSSIBLE.	
		Quantity.	Value.	Per cent of total value.	Quantity.	Value.
Total			$53,455,108	100.0		$90,947,244
Coke	Short tons	[1] 25,143,288	[1] 50,304,623	94.1	27,295,407	54,610,526
Tar	Gallons	26,223,323	613,388	1.2	295,273,173	6,906,697
Ammonium sulphate	Pounds	31,546,781	818,290	1.5	719,119,069	18,697,096
Ammonia liquor	Gallons	4,791,408	763,291	1.4		
Gas for consumption in ovens	Thousand cubic feet	16,232,309			183,025,147	
Surplus gas for sale	do	4,463,002	843,787	1.6	50,127,907	9,474,174
Unclassified by-products			108,532	0.2		1,222,733
All other products			3,197	(2)		36,018

[1] Includes 410,225 short tons valued at $1,302,572 made in establishments engaged primarily in the manufacture of other products.
[2] Less than one-tenth of 1 per cent.

The average yield of gas per ton of coal reported for the by-product ovens was 6,238 cubic feet. At this same rate the 37,376,251 tons of coal would have yielded 233,153,053,738 cubic feet. The percentage of the total gas produced in by-product ovens in 1905 which was sold was 21.6, and the average price at which it was sold was $0.189 per thousand cubic feet. Had all of the coal used in 1905 been coked in by-product ovens, the volume of gas available for sale, assuming the same percentage as for 1905, would have been 50,127,906,554 cubic feet, and its value at $0.189 per thousand cubic feet would have been $9,474,174, or there would have been an increase of $8,630,387 over the actual return. Proceeding in a similar manner for the coke, and assuming the same percentage yield of coke in coal, the increase in the yield of coke would have been 2,152,179 tons, and, at the same rate per ton, the increase in value would have been $4,305,903. Treating the data for tar in the same manner, and assuming the same yield per ton and same value per gallon as for that reported, the increase in the yield of tar would have been 269,049,060 gallons, and the increase in the value $6,293,309. Considering the ammonia compounds and assuming them to be recovered as ammonium sulphate, the increase in quantity would have been 656,485,652 pounds, and the increase in value, $17,115,515. From a similar point of view, the increase in value of the unclassified by-products would have been $1,114,201. From a comparison of the total value of the actual products shown in Table 13 with the total value of the possible products, it appears that there would have been a gain of $37,492,136, or 70.1 per cent, in value if all the coal coked in 1905 had been treated in by-product ovens. This increase is based on the assumption that the value per unit which obtained in 1905 would be maintained for the entire output. Such, however, would not be the case, for the supply of some, at least, of the by-products would greatly exceed the existing demand, and the value would consequently fall. Nevertheless, there will be an ultimate economic gain in the treatment of the coal in by-product ovens, for, with the growth of and improvements in the arts, there will be a constant increase in the demand for the products not only to apply more extensively to present uses, but, as such, to put to new uses, while many of them will undoubtedly become sources of new commercial products.

FOREIGN TRADE IN COKE AND COKE BY-PRODUCTS.

This industry is affected by foreign competition, and it is desirable to consider here the condition of our foreign commerce in the commodities which are the products of the coke industry. The statistics for this have been compiled from "Commerce and Navigation of the United States," issued annually by the Bureau of Statistics, Department of Commerce and Labor. Table 14 presents the quantity and value of coke imported into and exported from the United States for each year from 1896 to 1905. The importations and exportations for 1905 are included, for while the census year is from January to December, 1904, inclusive, the

fiscal year of the Treasury is from July 1, 1904, to June 30, 1905, and this would largely cover the period in which the manufactures of the calendar year 1904 were disposed of.

TABLE 14.—*Imports and exports of coke: 1896 to 1905.*

YEAR.	IMPORTS.		EXPORTS.			
			Domestic.		Foreign.	
	Long tons.	Value.	Long tons.	Value.	Long tons.	Value.
1896	44,812	$117,361	130,070	$500,169	202	$1,033
1897	27,293	71,692	155,072	557,046	1,070	3,650
1898	37,490	112,522	212,021	608,784	58	511
1899	51,435	172,540	215,513	632,788	.....	.....
1900	56,448	232,555	363,202	1,233,921	4	69
1901	75,104	309,594	365,888	1,433,497	1	32
1902	99,485	359,370	402,495	1,720,457	20	57
1903	122,630	414,017	380,038	1,912,450	.....	.....
1904	123,124	403,570	479,431	2,223,233	.....	.....
1905	196,008	835,481	550,188	2,228,442	56	479

It is surprising that there should have been such a quantity of so low priced a commodity imported as is shown for coke for 1905, and especially when there is at present an ad valorem duty of 20 per cent upon it. The importations of coke for 1905 were: From Belgium, 6 per cent; Germany, 14.8 per cent; United Kingdom, 18.8 per cent; Dominion of Canada, 60.3 per cent; Mexico, Japan, and British Australasia, collectively, one-tenth of 1 per cent. Of the importations from the Dominion of Canada, 62.5 per cent, or 73,856 long tons came from British Columbia, while the remainder was from Quebec, Ontario, and Manitoba. The export data indicate that the foreign trade in domestic coke is increasing constantly. Domestic coke was in 1905 exported to a considerable number of countries, but principally to the Dominion of Canada, Mexico, and Cuba; Quebec, Ontario, and Manitoba taking 299,203 long tons, or 54.4 per cent, of the total; Mexico, 241,262 long tons, or 43.9 per cent; Cuba, 8,343 long tons, or 1.5 per cent; and 16 other countries, two-tenths of 1 per cent.

Table 15 shows the number of barrels and the value of the crude coal tar and coal tar pitch imported into the United States for each year from 1896 to 1905, inclusive, and the quantity and value of the domestic coal tar which was exported for each year from 1902 to 1905.

TABLE 15.—*Imports and exports of coal tar, crude and pitch: 1896 to 1905.*

YEAR.	IMPORTS.		EXPORTS.	
	Barrels.	Value.	Barrels.	Value.
1896	141,515	$291,862	.....	.....
1897	111,526	259,490	.....	.....
1898	88,603	159,988	.....	.....
1899	25,049	57,853	.....	.....
1900	74,385	158,255	.....	.....
1901	37,959	101,044	.....	.....
1902	32,057	86,294	[1]14,555	[1]$41,062
1903	56,743	139,393	4,834	15,531
1904	43,732	83,039	6,383	19,284
1905	46,469	115,377	17,643	50,252

[1] Not stated separately prior to 1902.

Table 15 shows a growing though somewhat fluctuating exportation of domestic coal tar. Crude coal tar and coal tar pitch are admitted free of duty under the prevailing tariff act. Nevertheless, it is surprising that the quantity imported should be so large when it is considered that, according to W. H. Blauvelt,[1] 28 per cent of the tar produced in this country in 1905 was burned at the works, because of a lack of demand for it. The foreign coal tar and coal tar pitch imported in 1905 were supplied as follows: Germany, 896 barrels, or 1.9 per cent; United Kingdom, 21,756 barrels, or 46.8 per cent; and the Dominion of Canada, 23,817 barrels, or 51.3 per cent. Of the provinces forming the Dominion of Canada, Nova Scotia and New Brunswick are credited with supplying 18,635 barrels, or 78.2 per cent. The influence of the Otto-Hoffmann by-product ovens at Sydney, Nova Scotia, is thus clearly indicated. The domestic coal tar which was exported in 1905 was dispatched to some 29 different countries, and therefore shipped in small lots. The largest amount, 11,328 barrels, or 64.2 per cent of the total, was exported to Italy; 4,311 barrels, or 24.4 per cent, were sent to the Dominion of Canada; and 11.4 per cent to all other countries.

Table 16 sets forth the values of the coal tar products, which are not medicinal preparations, colors, or dyes, that were imported into the United States during each year from 1898 to 1905. These substances are, under the prevailing tariff act, imported free of duty and, according to the Treasury schedule, include benzol, toluol, naphthalene, xylol, phenol, cresol, toluidine, xylidin, cumidin, binitrotoluol, binitrobenzol, benzidin, tolidin, dianisidin, naphthol, naphthylamin, diphenylamin, benzaldehyde, benzyl chloride, resorcin, nitrobenzol, and nitrotoluol.

TABLE 16.—*Imports of coal tar products, not medicinal preparations, colors, or dyes: 1898 to 1905.*

YEAR.	Value.	YEAR.	Value.
1898	$228,037	1902	$368,098
1899	303,692	1903	425,069
1900	357,780	1904	391,645
1901	353,559	1905	468,352

Some of these substances, like benzol, toluol, naphthalene, cresol, and others are found occurring as such in the crude coal tar and may be obtained from it by distillation, or chilling and expression. Others of these bodies, like nitrobenzol and nitrotoluol, are products of the further manufacture of substances obtained from the coal tar. Some of these bodies, like benzol, may be obtained also from the gas from by-product ovens, and they are so commercially obtained in this country, and are included in Tables 12 and 13 of this report under "unclassified." No information has been obtained as to the countries from which these products are exported, but undoubtedly they are coun-

[1] Private communication.

tries which, like Germany, pursue the economic policy of utilizing labor in working up domestic raw material into manufactured products having an enhanced value.

Table 17 sets forth the quantity and value of the ammonium sulphate, carbonate, and chloride imported into the United States for consumption for each of the years from 1896 to 1905, inclusive.

TABLE 17.—*Imports for consumption of ammonium salts: 1896 to 1905.*

YEAR.	SULPHATE.		CARBONATE.		CHLORIDE.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1896	24,541,396	$480,971	643,621	$40,371	5,338,296	$283,329
1897	19,810,943	336,073	372,466	22,287	4,708,169	217,789
1898	16,413,443	277,531	179,440	10,128	4,002,740	168,613
1899	13,952,127	297,347	150,540	8,405	5,125,644	215,000
1900	16,822,090	423,096	298,788	19,851	5,065,057	214,957
1901	28,971,761	694,454	181,701	12,204	4,772,364	245,163
1902	36,291,938	842,699	280,837	17,308	6,690,551	328,572
1903	33,554,055	852,551	488,283	29,873	6,150,708	308,695
1904	33,333,767	886,403	787,016	52,556	6,841,860	351,768
1905	30,576,558	807,480	463,169	29,746	7,134,343	368,135

The salt indicated as chloride in Table 17 is also known as muriate of ammonia and as sal ammoniac. Besides the salts enumerated, beginning with 1902, there have been reported the following importations of phosphate of ammonia: 1902, 68,750 pounds, valued at $5,065; 1903, 231,867 pounds, valued at $15,650; 1904, 141,610 pounds, valued at $9,065; and 1905, 67,070 pounds, valued at $5,989. No aqua ammonia appears in this decade. The trade in this article seems to have ceased completely, for whereas in 1891 aqua ammonia was imported to the value of $12,858, in 1893 the value was but $718, and there has been no subsequent entry on the record. The various ammonium compounds imported here are obtained usually from bituminous coal, because the chief source of the ammonia in all ammonium compounds is to-day found in the ammoniacal liquor from by-product coke ovens, gas works, and blast furnaces, though synthetic methods of production have been invented and may come into commercial use. To show more fully the relations, the quantity of each of these salts, except the sulphate, which was imported in 1905, was converted into its equivalent weight of sulphate of ammonia, giving 8,707,116 pounds, which, added to the weight of the sulphate of ammonia, imported as such, gives a total of 39,283,674 pounds. The total value of all the ammonium salts imported in 1905 was $1,211,350. Each of these salts is subject to duty, the tariff being for sulphate 0.3 cent per pound, for carbonate 1.5 cents, and for muriate 0.75 cent, while on the phosphate the duty levied is 25 per cent ad valorem. Notwithstanding these duties, and the enormous quantity of ammoniacal liquor that is permitted to escape from beehive and Belgian ovens and to be totally lost, this importation of foreign ammonium salts tends, on the whole, steadily to increase.

Table 18 gives detailed statistics of the coke industry, by states and territories, as reported at the census of 1905. This table shows that the total horsepower for establishments classified under "coke" in 1905 was 75,991. A comparison with the figures for 1900, from which the amount of power of locomotives and pumps has been deducted, since it was not enumerated in 1905, shows an increase of 45,374 horsepower, or 148.2 per cent. The increase in steam horsepower was 30,681, or 105.3 per cent, and in electric power owned and rented 9,047, or 618.8 per cent. In 1905 steam-power was 78.7 per cent of the total horsepower and electric power 13.8 per cent. In 1900 they were 95.2 and 4.8 per cent, respectively. Gas or gasoline horsepower increased from 7 to 150.

TABLE 18.—COKE—DETAILED SUMMARY,

		United States.	Alabama.
1	Number of establishments	278	24
2	Capital	$90,712,877	$3,425,193
3	Land	$8,374,672	$133,242
4	Buildings	$14,235,683	$87,902
5	Ovens	$50,862,467	$2,541,487
6	Machinery, tools, and implements	$8,703,863	$347,893
7	Cash and sundries	$8,536,192	$314,669
8	Proprietors and firm members	73	
	Salaried officials, clerks, etc.:		
9	Total number	1,386	107
10	Total salaries	$1,247,502	$95,518
	Officers of corporations—		
11	Number	187	34
12	Salaries	$309,011	$23,327
	General superintendents, managers, clerks, etc.—		
13	Total number	1,199	73
14	Total salaries	$938,491	$72,191
	Men—		
15	Number	1,154	72
16	Salaries	$918,195	$71,471
	Women—		
17	Number	45	1
18	Salaries	$20,296	$720
	Wage-earners, including pieceworkers, and total wages:		
19	Greatest number employed at any one time during the year	24,662	2,602
20	Least number employed at any one time during the year	16,355	1,492
21	Average number	18,981	2,165
22	Total wages	$9,304,498	$923,983
	Men 16 years and over—		
23	Average number	18,915	2,155
24	Wages	$9,290,216	$921,813
	Children under 16 years—		
25	Average number	66	10
26	Wages	$14,282	$2,170
	Average number of wage-earners, including pieceworkers, employed during each month:		
	Men 16 years and over—		
27	January	17,385	2,264
28	February	17,877	2,386
29	March	18,949	2,408
30	April	19,545	2,449
31	May	19,500	2,472
32	June	19,127	2,457
33	July	16,837	1,693
34	August	17,606	1,743
35	September	19,239	1,880
36	October	19,360	1,988
37	November	20,215	2,031
38	December	21,340	2,089
	Children under 16 years—		
39	January	62	11
40	February	58	12
41	March	62	13
42	April	63	11
43	May	64	11
44	June	68	15
45	July	56	7
46	August	63	2
47	September	68	4
48	October	73	11
49	November	75	12
50	December	80	11
	Miscellaneous expenses:		
51	Total	$4,891,130	$156,902
52	Rent of works	$64,287	$2,000
53	Fire brick, cement, etc., used in repairing ovens	$500,372	$52,859
54	Taxes	$451,082	$16,416
55	Rent of offices, insurance, interest, and all other sundry expenses not hitherto included	$3,873,299	$85,627
56	Contract work	$2,090	
	Materials used:		
57	Aggregate cost	$29,884,532	$3,997,247
	Coal charged into ovens—		
58	Total short tons	36,781,006	4,027,656
59	Total cost	$28,360,121	$3,799,827
	Run of mine—		
	Unwashed—		
60	Short tons	24,872,731	832,764
61	Cost	$17,100,051	$898,081
	Washed—		
62	Short tons	2,649,251	1,266,681
63	Cost	$3,290,181	$1,246,787
	Slack—		
	Unwashed—		
64	Short tons	4,414,326	4,933
65	Cost	$3,403,148	$6,602
	Washed—		
66	Short tons	4,844,698	1,933,288
67	Cost	$4,566,741	$1,648,407
68	Fuel other than charged into ovens	$336,499	$21,837
69	Mill supplies	$274,999	$74,560
70	All other materials	$872,001	$71,683
71	Rent of power and heat	$1,733	
72	Freight	$39,179	$29,340
	Products:		
73	Aggregate value	$51,728,647	$6,175,126
	Coke—		
74	Total short tons	24,733,063	2,335,613
75	Total value	$49,002,051	$5,731,329
	From beehive ovens—		
76	Short tons	22,512,152	1,942,177
77	Value	$42,876,194	$4,933,059
	From retort or by-product ovens—		
78	Short tons	2,216,783	393,436
79	Value	$6,116,278	$798,270

[1] Exclusive of the statistics of 17 establishments making coke, but engaged primarily in the manufacture of other products; these establishments produced 410,225 short tons of coke, valued at $1,392,572.

BY STATES AND TERRITORIES: 1905.[1]

Colorado.	Indian Territory.	Kansas.	Kentucky.	Ohio.	Pennsylvania.	Tennessee.	Virginia.	West Virginia.	All other states.[1]	
13	3	3	6	4	110	9	13	74	19	1
$3,128,136	$116,806	$33,166	$178,686	$583,913	$56,828,875	$733,425	$3,467,449	$8,063,570	$14,143,658	2
$30,200	.....	.....	$940	$3,608	$6,924,572	$32,250	$451,457	$36,029	$762,314	3
$43,297	$6,500	$800	$10,800	$22,432	$12,214,790	$16,354	$322,137	$921,627	$889,044	4
$2,060,674	$45,000	$21,996	$84,434	$10,200	$28,316,452	$637,980	$1,797,628	$6,329,838	$9,025,778	5
$968,965	$53,806	$4,634	$53,200	$363,100	$3,474,715	$24,702	$507,283	$640,472	$2,205,003	6
$25,000	$11,500	$5,736	$20,312	$184,513	$5,908,346	$22,049	$388,944	$444,604	$1,201,519	7
.....	.....	.....	.....	1	72	.....	.....	.....	.....	8
36	4	.....	4	12	749	39	70	231	134	9
$26,637	$2,810	.....	$8,000	$12,504	$733,617	$24,315	$58,147	$160,032	$125,922	10
.....	1	.....	3	1	71	9	13	35	20	11
.....	$250	.....	$6,000	$500	$196,798	$7,985	$16,500	$27,123	$30,528	12
36	3	.....	1	11	678	30	57	196	114	13
$26,637	$2,560	.....	$2,000	$12,004	$536,819	$16,330	$41,647	$132,909	$95,394	14
36	3	.....	1	10	637	30	55	196	114	15
$26,637	$2,560	.....	$2,000	$11,604	$518,243	$16,330	$41,047	$132,909	$95,394	16
.....	.....	.....	.....	1	41	.....	2	.....	.....	17
.....	.....	.....	.....	$400	$18,576	.....	$600	.....	.....	18
1,637	111	24	132	153	12,452	476	1,479	3,627	2,559	19
342	79	7	89	73	9,342	347	1,072	2,075	1,446	20
581	90	11	92	113	10,154	377	1,094	2,533	1,771	21
$371,897	$44,013	$5,562	$40,493	$54,343	$5,172,736	$128,568	$449,120	$1,003,592	$1,119,191	22
578	90	11	92	113	10,139	377	1,064	2,525	1,771	23
$370,977	$44,013	$5,562	$40,493	$54,343	$5,168,751	$128,568	$434,963	$1,001,542	$1,119,191	24
3	.....	.....	.....	.....	15	.....	30	8	.....	25
$920	.....	.....	.....	.....	$3,985	.....	$5,157	$2,050	.....	26
124	105	17	121	114	9,081	443	953	2,839	1,324	27
162	92	17	103	114	9,586	436	868	2,749	1,364	28
319	86	17	94	114	10,251	440	921	2,840	1,429	29
451	79	21	105	114	10,628	421	961	2,793	1,523	30
607	79	21	95	114	10,516	412	922	2,654	1,608	31
699	80	10	84	114	10,162	414	899	2,538	1,679	32
768	80	3	74	112	8,950	326	875	2,291	1,695	33
762	83	7	71	112	9,217	321	1,216	2,014	2,060	34
688	80	8	83	112	10,420	324	1,269	2,102	2,264	35
704	94	4	82	112	10,243	319	1,249	2,321	2,244	36
765	102	4	92	112	10,899	326	1,310	2,507	2,067	37
887	111	3	100	112	11,685	342	1,334	2,682	1,995	38
.....	.....	.....	.....	.....	15	.....	29	7	.....	39
.....	.....	.....	.....	.....	15	.....	25	6	.....	40
.....	.....	.....	.....	.....	16	.....	26	7	.....	41
3	.....	.....	.....	.....	15	.....	27	7	.....	42
3	.....	.....	.....	.....	16	.....	26	8	.....	43
5	.....	.....	.....	.....	13	.....	26	9	.....	44
5	.....	.....	.....	.....	8	.....	27	9	.....	45
5	.....	.....	.....	.....	14	.....	33	9	.....	46
5	.....	.....	.....	.....	15	.....	34	10	.....	47
4	.....	.....	.....	.....	15	.....	35	8	.....	48
3	.....	.....	.....	.....	17	.....	35	8	.....	49
3	.....	.....	.....	.....	21	.....	37	8	.....	50
$38,372	$6,000	$305	$7,963	$9,400	$3,363,421	$21,035	$52,643	$369,906	$865,183	51
$1,500	$1,500	.....	$89	$500	$27,357	.....	$4,970	$25,753	$618	52
$36,442	$3,000	.....	$2,494	$225	$321,284	$10,105	$12,877	$36,738	$24,348	53
$125	.....	$305	$1,384	$1,650	$330,727	$3,087	$10,238	$32,241	$54,300	54
$60	$1,500	.....	$3,996	$7,025	$2,682,208	$7,243	$24,558	$275,174	$785,908	55
$245	.....	.....	.....	.....	$1,845	.....	.....	.....	.....	56
$985,817	$101,366	$16,392	$21,253	$170,423	$14,978,581	$610,855	$1,183,079	$2,647,482	$5,172,037	57
1,000,206	100,870	10,751	89,395	113,319	23,083,044	573,629	1,676,256	3,628,673	2,477,207	58
$922,394	$93,062	$16,392	$18,698	$169,923	$14,423,048	$582,401	$1,105,432	$2,580,118	$4,048,766	59
26,590	.....	.....	.....	.....	20,595,557	1,471	1,297,706	1,413,466	705,187	60
$13,621	.....	.....	.....	.....	$12,465,659	$1,681	$845,046	$1,216,904	$1,659,059	61
26,008	.....	.....	.....	.....	505,527	192,379	90,141	3,253	575,262	62
$14,485	.....	.....	.....	.....	$515,693	$266,206	$58,619	$2,178	$1,186,263	63
207,669	80,870	10,751	14,521	6,796	1,079,682	58,703	288,409	2,063,934	508,058	64
$263,847	$72,062	$16,392	$8,864	$8,017	$810,312	$56,684	$201,767	$1,261,252	$691,349	65
649,939	20,000	.....	74,874	106,523	902,278	321,076	.....	148,020	688,700	66
$630,441	$21,000	.....	$9,834	$161,906	$625,384	$257,890	.....	$99,784	$1,112,095	67
$15,500	$600	.....	$806	.....	$129,322	$7,230	$22,162	$19,143	$119,899	68
$13,993	$7,704	.....	$476	$500	$77,229	$4,652	$19,548	$16,433	$59,904	69
$33,930	.....	.....	$75	.....	$347,233	$9,312	$35,937	$30,303	$343,408	70
.....	.....	.....	.....	.....	$1,733	.....	.....	.....	.....	71
.....	.....	.....	$1,198	.....	$16	$7,200	.....	$1,425	.....	72
$1,723,276	$189,861	$20,588	$100,194	$259,058	$28,924,229	$809,801	$1,884,570	$4,174,186	$7,467,758	73
585,662	41,061	6,776	45,112	65,170	16,273,046	324,451	1,139,010	2,282,147	1,635,015	74
$1,723,276	$189,861	$20,588	$100,194	$181,889	$28,593,136	$809,801	$1,882,849	$3,986,081	$5,783,047	75
585,662	41,061	6,776	45,112	23,369	15,767,652	324,451	1,139,010	2,120,791	516,031	76
$1,723,276	$189,861	$20,588	$100,194	$77,385	$27,542,495	$809,801	$1,882,849	$3,502,013	$2,094,673	77
.....	.....	.....	.....	41,801	505,394	.....	.....	161,356	1,114,796	78
.....	.....	.....	.....	$104,504	$1,050,641	.....	.....	$484,068	$3,678,795	79

[1] Includes establishments distributed as follows: Georgia, 2; Illinois, 1; Maryland, 1; Massachusetts, 1; Minnesota, 1; Montana, 1; New Jersey, 1; New Mexico, 2; New York, 2; Utah, 2; Washington, 2; Wisconsin, 2; Wyoming, 1.

TABLE 18.—COKE—DETAILED SUMMARY

		United States.	Alabama.
	Products—Continued.		
	Coke—Continued.		
	From other ovens—		
80	Short tons	4,128	
81	Value	$9,579	
	Tar—		
82	Gallons	23,074,225	4,081,211
83	Value	$551,836	$91,827
	Ammonium sulphate—		
84	Pounds	26,050,713	5,165,294
85	Value	$681,427	$103,306
	Ammonia liquor—		
86	Gallons	4,339,679	576,664
87	Value	$607,644	$175,707
88	Total amount of gas made, cubic feet	18,761,101,300	
89	Deduct amount used in process or wasted, cubic feet	14,878,300,900	
	Gas sold—		
90	Total cubic feet	3,882,800,400	
91	Total value	$684,464	
	For illuminating—		
92	Cubic feet	3,747,408,300	
93	Value	$668,487	
	For fuel—		
94	Cubic feet	135,392,100	
95	Value	$15,977	
96	All otherproducts, value	$111,225	$72,957
	Power:		
97	Number of establishments reporting	197	17
98	Total horsepower	75,991	3,385
	Owned—		
	Engines—		
	Steam—		
99	Number	686	57
100	Horsepower	59,829	3,075
	Gas or gasoline—		
101	Number	4	
102	Horsepower	150	
	Water motors—		
103	Number	9	
104	Horsepower	188	
	Electric motors—		
105	Number	356	11
106	Horsepower	9,322	310
107	Other power, horsepower	5,315	
	Rented—		
	Electric motors—		
108	Number	27	
109	Horsepower	1,187	
110	Furnished to other establishments, horsepower	112	

BY STATES AND TERRITORIES: 1905—Continued.

Colorado.	Indian Territory.	Kansas.	Kentucky.	Ohio.	Pennsylvania.	Tennessee.	Virginia.	West Virginia.	All other states.	
									4,128	80
									$9,579	81
				778,860	3,815,240			2,160,852	12,238,062	82
				$13,464	$84,812			$54,765	$300,968	83
					1,467,317				19,418,102	84
					$38,733				$539,388	85
				287,063	1,334,775			564,084	1,577,093	86
				$26,440	$190,164			$133,340	$171,993	87
				366,225,000	4,772,401,000				13,622,475,300	88
				291,553,500	4,638,367,400				9,948,380,000	89
				74,671,500	134,033,600				3,674,095,300	90
				$31,265	$11,569				$041,630	91
				74,671,500	35,201,600				3,637,535,200	92
				$31,265	$3,520				$633,702	93
					98,832,000				36,560,100	94
					$8,049				$7,928	95
					$5,815		$1,721		$30,732	96
11	2		4	2	81	6	10	51	13	97
3,806	110		170	350	48,955	405	5,495	3,907	9,408	98
42	2		7	2	404	5	38	60	69	99
3,806	110		170	350	38,308	315	4,755	3,222	5,718	100
						1			3	101
						39			120	102
					9					103
					188					104
					164		14	10	157	105
					4,477		665	400	3,470	106
					5,240		75			107
					10	2		13	2	108
					742	66		285	100	109
									112	110

HISTORICAL AND DESCRIPTIVE.

GEOGRAPHIC DISTRIBUTION.

It is of interest to study the geographic location of coke plants in the United States at different periods, a subject which may perhaps be best initiated by the following quotation from the report of the census of 1880:

At the census of 1860 coke is returned as made in Allegheny, Cambria, Clarion, and Fayette counties, Pennsylvania. These counties are, respectively, in the Pittsburg, Allegheny Mountain, Allegheny River, and Connellsville districts, so that at that date what are now the chief coke producing regions of Pennsylvania were engaged in its manufacture.

A remark similar to that made concerning the statistics of 1850 is also applicable to those of 1860, as coke was doubtless made in other counties of Pennsylvania than those named. In a work published in Pittsburg in 1857 the statement is made:

"The coke iron consumed by the manufacturers of Pittsburg is at present obtained both from a distance and from the neighborhood. The metal of this description made from the fossil ores of the central counties of Pennsylvania is excellent for castings. * * * From the neighboring counties of Fayette, Cambria, Beaver, Mercer, and Lawrence coke metal is now brought to Pittsburg."

This would add Beaver, Mercer, and Lawrence counties to the coke producing sections of Pennsylvania. The Clinton furnace at Pittsburg, working entirely with coke as a fuel, was also blown in during the fall of 1859, and, though small, its consumption of coke would have been a considerable proportion of that reported made in the census year 1860. Altogether, the indications are that the returns for 1860 are very incomplete, as they omit many localities at which coke was made and fail to report much that was made, or do not report it as coke.

In 1870 Ohio for the first time appears in the census as a manufacturer of coke, it being made in Hamilton, Jefferson, and Tuscarawas counties. The coke made in Hamilton county was probably made from the screenings gathered from the different coalyards. In this year, according to the report, coke was made in Pennsylvania in Allegheny, Armstrong, Cambria, Clarion, and Fayette counties, Armstrong being the only county in which coke was reported as made at the Ninth Census in which it was not reported as made at the Eighth.

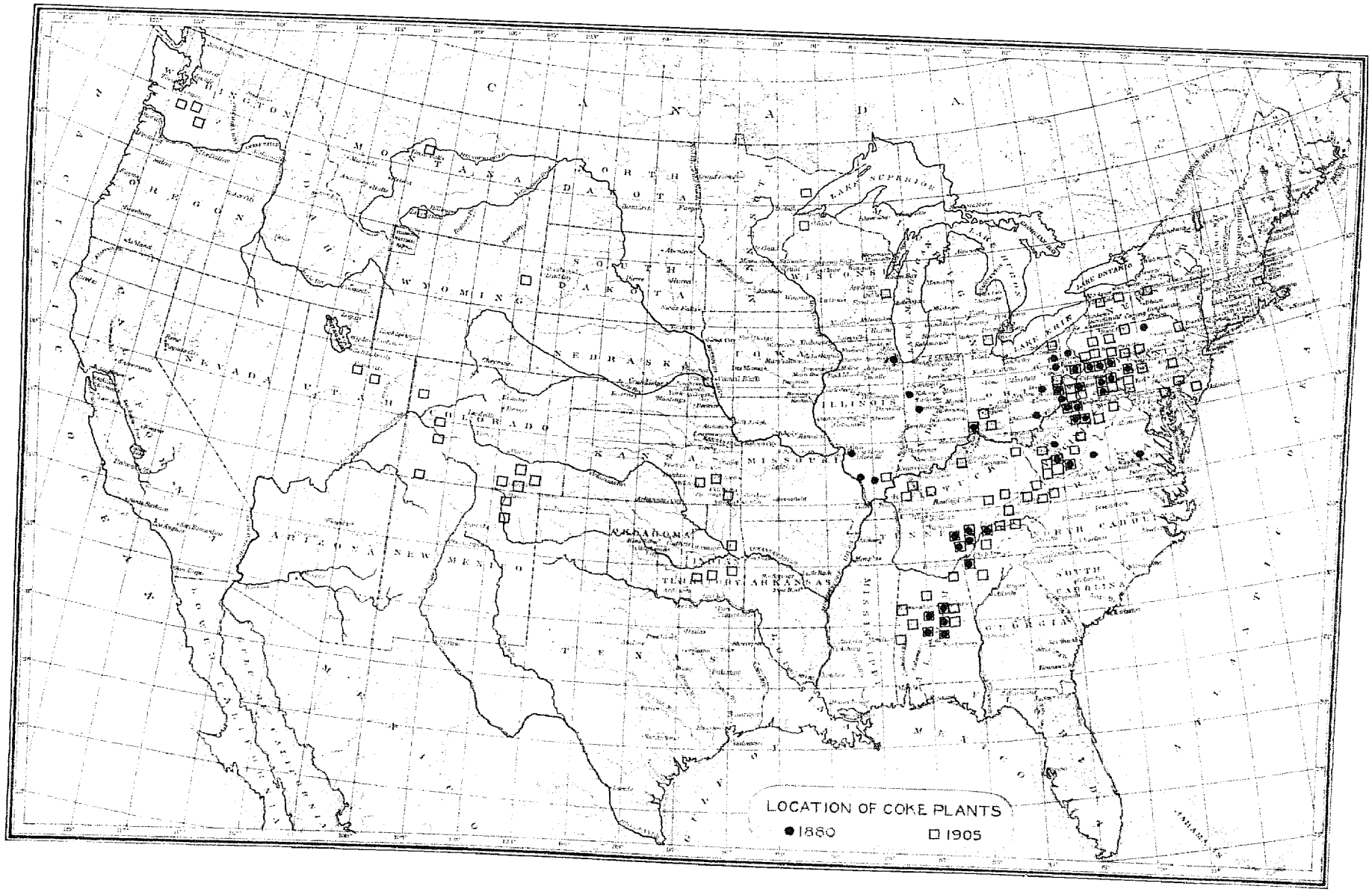
In the census of 1880 it will be noticed that coke is reported as being manufactured in nine states: Alabama, Colorado, Georgia, Illinois, Indiana, Ohio, Pennsylvania, Tennessee, and West Virginia. Two establishments for the manufacture of coke are reported in Virginia near Richmond, but no coke was made in this state in the census year 1879-80. * * *

From an inspection of the map accompanying this report and a comparison of the figures given in the tables showing the localities and production it will be seen that the coke producing belt of the country is the bituminous coal measures of the Appalachian chain. Beginning very nearly at the extreme northern point of the Allegheny mountains in Pennsylvania, the coke ovens follow this range of the Appalachians nearly to their southern limit, at Huntsville, Ala. Outside the limit of this region the make of coke in the census year was but 26,600 tons out of a total of 2,752,475, or less than 1 per cent. It will also be noticed that the center of production is the Connellsville region of Pennsylvania.

No doubt coke in considerable quantities will be manufactured in the future in other states. Already there is promise of this in certain sections of Illinois and in Colorado, but for many years it is probable that the bulk of the coke of the country will be produced along the Allegheny mountain range, from the coal measures of which such a large percentage is now supplied.

In 1890 Indian Territory, Kansas, Kentucky, Missouri, Montana, Utah, Virginia, Washington, and Wisconsin were added to the list of coke producing states and territories. In 1900 Massachusetts, New Mexico, New York, and Wyoming were added, and in 1905 Maryland, Minnesota, and New Jersey. Before 1890 the manufacture of coke was carried on only in states that produced bituminous coal. The Census Report on Mines and Quarries shows that in 1902 no bituminous coal was produced in 5 of the states which have engaged in the production of coke since 1880, namely, Massachusetts, Minnesota, New Jersey, New Mexico, and Wisconsin. However, the location of the coke establishments with respect to the deposits of bituminous coal from which they are supplied can not be set forth accurately by a mere enumeration of the states and territories in which the coke establishments are to be found, for the position of an establishment within a state is often of equal importance. The single coke establishment reported from Maryland in 1905 is located on the shore of Chesapeake Bay, while the bituminous coal mines of Maryland are in the extreme western part of the state. The development of this industry is graphically set forth in the chart facing this page on which the location of works in 1880 is shown by circles drawn on a map of the United States, and the location of works in 1905 is shown by rectangles. By inspection of this chart it is evident that the "coke producing belt" still follows, in the main, the bituminous coal deposits of the Appalachian range, and that as the industry has extended outside this belt it has, to a large extent, been located near other deposits of bituminous coal. Yet, as instanced above, there are marked departures from this rule, including the location of some of the most recently established and most modern plants.

From the study of the history of this industry it appears that in the earlier days coke was used solely as a fuel and reducing agent in isolating iron from its ores, and in working it into marketable forms. The object sought in the coke industry was simply to convert an abundant supply of unsuitable material (bituminous coal) into a material that would bear the burden of the blast furnace. To-day the coke industry not only serves its former uses, but is an important source of those prime industrial factors, heat, light, and power, and, incidentally it furnishes valuable materials in great variety as by-products. Naturally, coke ovens were at first erected and operated in the coal fields close to the source of supply, and, as pointed out, this custom still prevails to a considerable extent. It was one factor determining the location as the industry extended; but with the growth and improvement in transportation facilities,


LOCATION OF COKE PLANTS
● 1880
□ 1905

and especially with the rapid increase in the coal-carrying capacity of railroads per unit of power expended, it was found that, while still practicing the art in the old way, there was an economic gain in transporting the compact coal rather than the more bulky coke, notwithstanding the loss of a large percentage of the coal in coking. The practice thus grew of locating coke ovens near blast furnaces and other points of consumption; a practice which was already begun in 1880. With the introduction of by-product ovens this advantage in transporting the coal to points where not only coke, but the by-products, could be used most economically was emphasized, and in recent years coke plants have been located not only near blast furnaces and steel works, but at chemical works also, and recently near great centers of population fairly remote from coal fields, where they have come into active competition with gas companies in supplying gas for light and heat and where the coke is used largely as a domestic fuel. Thus, in speaking of the by-product establishments in operation in the United States in 1903, Pennock says:[1] "Of the 20 plants, 16 are located near blast furnaces, 2 at soda ash plants, and 2 are built adjacent to cities which are supplied with illuminating gas. Of the 16 plants located at blast furnaces which are supplied with coke 8 also supply gas for illuminating purposes."

PROCESS OF MAKING COKE.

Bituminous coal is converted into the coherent, carbonaceous substance called coke by a process of "dry" or "destructive" distillation, in which its volatile portions are driven off from the main body. The operation is carried on in the United States in beehive ovens, in Belgian or flue ovens, and in by-product ovens. Coal was formerly coked in heaps, piles, or mounds, or in open kilns, but these methods have become obsolete in this country. They are described in detail, and accompanied by illustrations in the Report on the Manufacture of Coke of the census of 1880. This report also treats at length of the beehive and Belgian ovens, so it will suffice to refer but briefly to these types here, especially as in their main features they remain practically unchanged to-day.

Beehive ovens.—The beehive oven is built of brick or stone, is cone-shaped in the interior and has an exterior the shape either of a rectangular prism or with one or more of the sides slanting inward from the base. Coal is poured in and the gases escape through an opening in the top, while the coke is taken out through an opening in the face of the oven near the base, which also permits the proper amount of air to enter. To facilitate the withdrawal of the coke, the bottom of the oven is usually inclined toward the front. The standard ovens, designed by John Fulton, and used in the coking tests by the United States Geological Survey at St. Louis in 1904, were 12 feet in diameter and 7 feet in height. They are usually built in batteries for economy in construction, operation, and heating, and frequently two batteries are placed back to back within the same inclosing walls. The coal is charged into the oven through the top opening from a car or larry running on tracks resting on the filling above the oven dome, and then is leveled off by a rake worked by hand or sometimes by a mechanical leveler, after which the door is closed by bricking up, leaving a few interstices and a small air space at the top above the level of the coal charge. The heat remaining in the oven brickwork from previous operations or from a preliminary heating up starts the distillation, and the evolved gas becomes ignited and burns with the air entering at the interstices in the door. By this means the arched dome of the oven is heated, and it reflects and radiates heat upon the coal below, thus continuing the decomposition until only coke remains. When the gas is burned off, water is turned into the furnace to arrest combustion and to give the coke a silver-gray luster, and the coherent mass is cracked so that it may be withdrawn. The coke is then drawn from the oven by hand rakes or by machinery, and the operation is repeated. The charge of coal used is from 4½ to 5 net tons of coal for a 48-hour coking period and somewhat more for a 72-hour coking period, but in either case the oven is only partly filled by the coal, leaving a large space above it. The coking periods are usually so arranged as to avoid drawing coke on Sunday, two 48-hour charges and one 72-hour charge constituting a week's work. During the coking the coal gives off in the gas quantities of heavy hydrocarbons, which, in burning at the upper opening of the oven, emit great volumes of dense smoke.

Belgian ovens.—The term "Belgian ovens" includes a number of forms of coke ovens, among which may be enumerated the Dulait, the Coppée, and the Appolt. They differ radically from the beehive ovens in three particulars: (1) In the exclusion of air from the coking chamber, the heating necessary for coking being applied from the outside; (2) in the utilization of the waste heat and gases to facilitate the process of coking; (3) in their operation. Coking in beehive ovens proceeds from the top of the charge of coal downward, the heat is supplied by the combustion of the gases evolved from the coal and of part of the coal itself within the oven, and the coke is also quenched in the oven. Coking in Belgian ovens, on the other hand, proceeds simultaneously from the sides, bottom, and top of the coal charge inward toward the center, the heat necessary being supplied by the combustion in flues in the walls of the oven, of the gases of distilla-

[1] V. Internationaler Kongress für angewandte Chemie, vol. 2, page 781.

tion previously collected, and the coke is quenched outside the oven.

The various types of Belgian ovens above enumerated differ in features of construction and in the arrangement of their flues. The Coppée oven, which is one of the best known, may be taken as an example of all. These ovens are built of brick in pairs, so that one may be charged as the other is ready to be discharged, and these pairs are grouped in batteries of thirty. Each oven is 26 feet 6 inches long, 4 feet high, and varies in width from 19 inches at the discharging end to 17 inches at the front. Connected with each oven are a number of vertical flues through which the volatile products of both ovens of a pair are conveyed downward to a horizontal flue under one of them. Then, after passing the length of this oven, the gases return by a similar flue under the other and enter a channel running at right angles to the ovens and under them, passing from this channel either directly into a chimney or under boilers where they are used to generate steam. Air is supplied to these vertical flues in the sides of the ovens by smaller vertical flues, there being one or two to each oven, connected with the top near the center charging hole, the air becoming heated while passing through the flue.

The ovens are charged through three hoppers in the top and are drawn by means of a mechanical ram propelled by a cogged driving wheel worked by a small portable engine. At each end of an oven are two iron doors moving on hinges and fixed securely in metal frames, the lower 3 feet high, the upper 1 foot. In working the ovens it is necessary first to heat them thoroughly, which is done by lighting fires of coal close to the doors at the end of every oven. When the ovens are sufficiently hot, they are charged. The first few charges of coal are in small lumps, the coke produced being of an inferior quality; but in a few days the ovens become so thoroughly heated that crushed coal of the consistency of very coarse meal is used, it being washed, if necessary, to remove impurities. When the charge is to be withdrawn, the front and back doors are opened and the mass of coke pushed out by a ram. The ram is quickly withdrawn and the two lower doors are closed. The oven is then charged immediately through the hoppers or openings in its top, and the coal is leveled with rakes by two men working through the upper doors at each end. The doors are then closed and carefully luted, and carbonization commences immediately. The processes of discharging and charging the ovens need not occupy more than eight minutes. The coke is quenched immediately on being withdrawn. Six charges are coked in each oven per week, each charge yielding about two tons of coke.

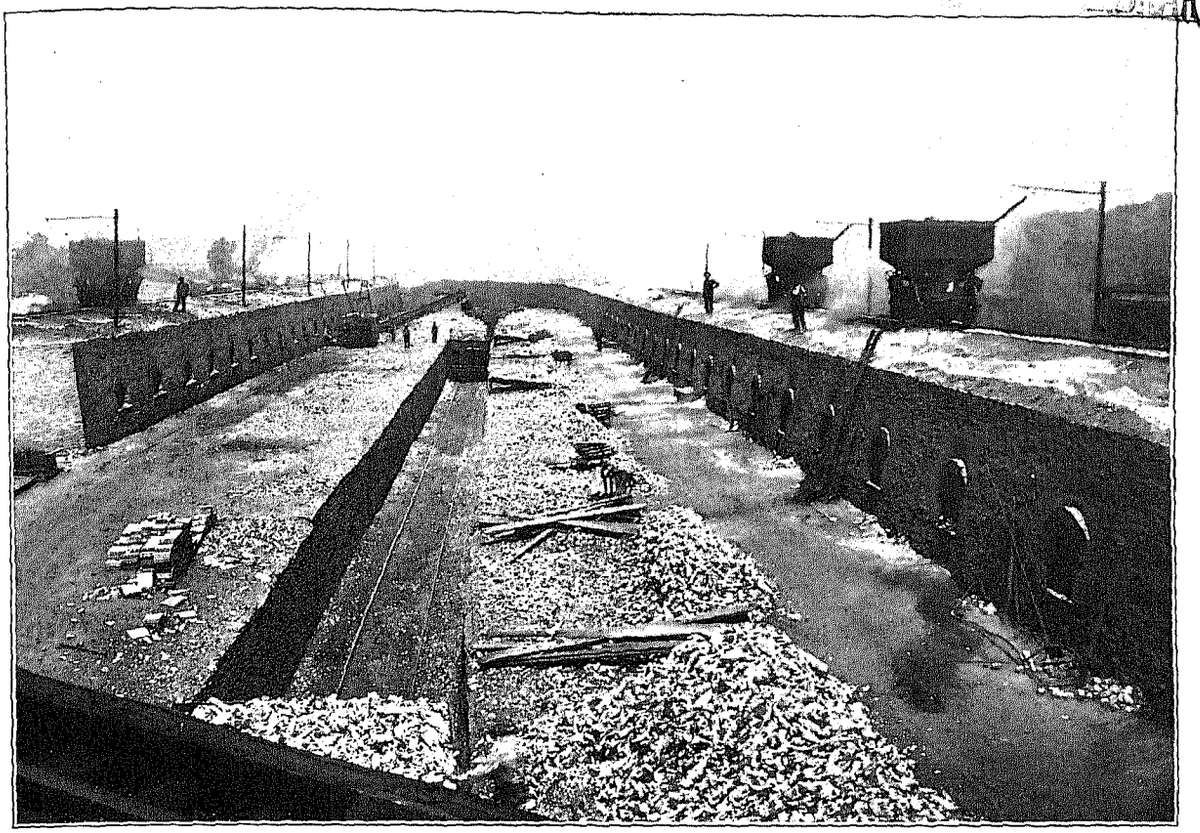
Weeks records the building of 80 Coppée ovens in 1880 at Goshen Bridge, Va., by the Iron and Steel Works Company of Virginia to coke coal from the New River region, West Virginia, and the operation of Belgian ovens in Illinois as early as 1872.

BY-PRODUCT OVENS.

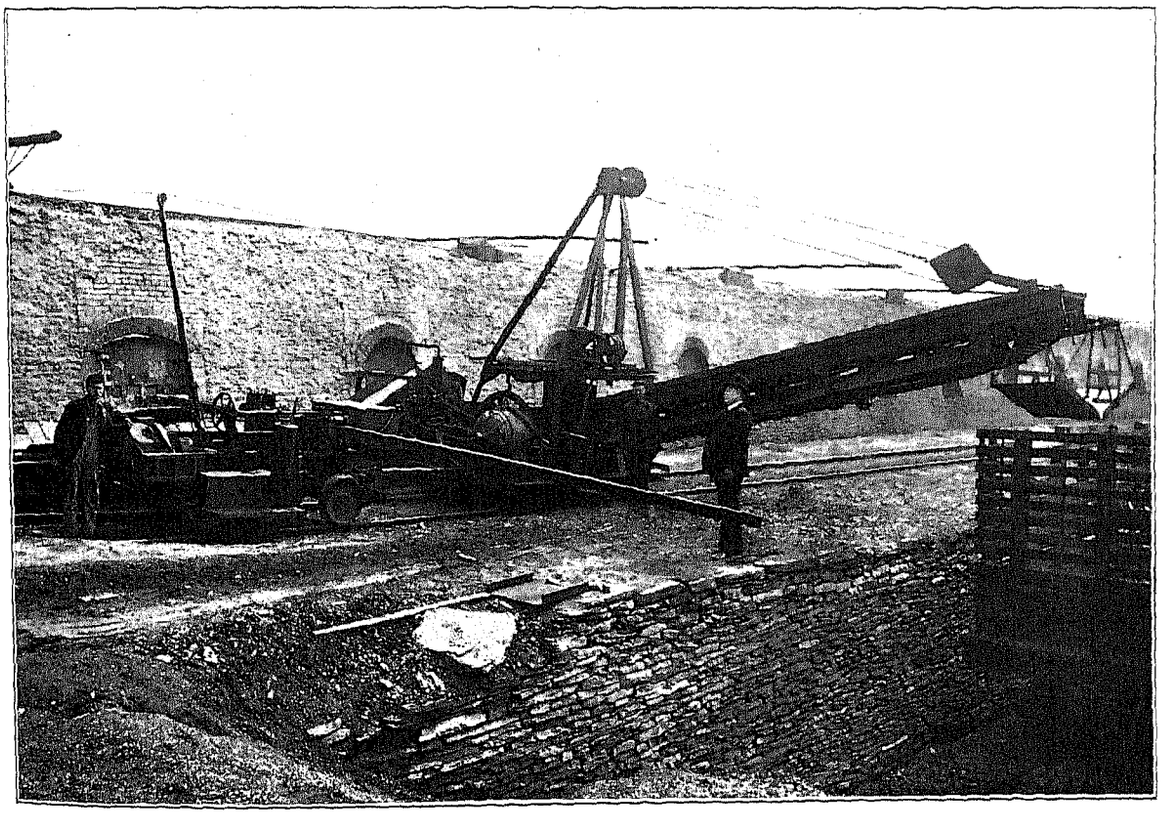
In the "beehive" and Belgian ovens no effort is made to save any portion of the matter volatilized, yet the possibility of effecting this saving has long been known, for Goethe states that in 1771 Stauf, near Saarbrücken, endeavored in his "connected row of furnaces" to "cleanse the coal from sulphur for use in iron works" and "also turn the oil and resin to account, not even losing the soot," but that "all failed because of the many ends in view." According to Blauvelt, "It was not until 1855 that Pauwels, Dubochet, and Carl Knab, working on different lines, successfully operated coke ovens where the tar and ammonia were saved. A few years later Carvés added side flues to Knab's design, and the by-product oven in its essentials became a fact, although it was not until 1881 that the condensation of ammonia and tar was a success along with the production of a good quality of coke." This Knab-Carvés oven was the progenitor of the Semet-Solvay by-product oven, while the Coppée oven was the forerunner of the Otto-Hoffmann by-product oven. In the Census report for 1880, Weeks gives a detailed description of the Siemens, or Simon-Carvés, oven as operated at Bességes, France, by the Terrenoire Company from 1867 to 1879, showing for each year the number of ovens operated and the yields. In 1879 they operated 96 of these ovens, coking 46,900 tons of coal and producing 33,092 tons of coke, 1,099 tons of tar, and 4,393 tons of ammoniacal liquor. The yield of coal in coke was 75 per cent. No gas is accounted for, and about 35 pounds of "small fuel" was burned for each ton of coke produced. An itemized statement of cost of constructing 100 Carvés ovens is given, the total reaching about $192,442.

The first known mention of the utilization of by-products from coking in the United States is the statement in the census of 1880 that the Consolidated Gas Company of Pittsburg collected the gas from beehive ovens and distributed it for lighting purposes. The first plant of modern by-product ovens built in the United States was a battery of 12 Semet-Solvay ovens erected at Syracuse, N. Y., in 1892.

Characteristics of by-product ovens.—By-product ovens, such as are in use in the United States, are narrow rectangular cells with openings the full size of the cross section of the cells at either end, which, when in use, are closed by slab-like doors that may either slide vertically in grooves or be wholly detachable, and when put in place are sealed by luting with clay or by other means to make them gastight. These ovens are built largely of refractory brick, in batteries or blocks to prevent, so far as possible, loss of heat by radiation and convection, for when they are so built the heat of the adjacent ovens is necessarily interchanged. The coal



BEEHIVE OVENS AT UNIONTOWN, PENNSYLVANIA.



COKE DRAWER AND LOADER FOR BEEHIVE OVENS.

in the ovens is carbonized by the heat produced by the combustion of gas in flues placed in the partition walls which divide the ovens in the battery, so that the process is one of destructive distillation pure and simple. The battery is placed above two systems of flues or regenerators. Through the first the combustible mixture of gas and air is led in to the combustion flues in the side walls of the oven. Through the second the gaseous products of combustion are led out to the chimney stack. By this arrangement some of the heat carried out by the products of combustion is utilized in heating the ingoing gases, thus not only effecting a saving of fuel, but also furnishing a higher temperature at the point of combustion than could be obtained if cold gases were used.

In the upper part of each oven are several openings through which the coal may be dropped in charging the ovens. In the top of the ovens are openings connected with mains through which the volatile substances produced by the distillation pass out and are carried to various reservoirs as they are separated by condensation into gas, ammoniacal liquor, and tar. These openings are usually at the extreme ends of the ovens just inside the doors. Where the gas produced is used as fuel gas only, there is but one of these openings and one set of mains, but where part of the gas is used for illuminating purposes and part for fuel, there are two openings and two sets of mains, so that during the first part of the heating, when rich gas is produced, this may be drawn off through one of the mains, and later when the lean gas is produced, this may be drawn off through the other main. In ovens of the class described the gas used for heating is a part of that produced in the distillation of previous charges of coal, but before it is used as fuel it is cleansed by scrubbing and condensing, as in the manufacture of coal gas.

As this process involves not only the production of coke but also the recovery and utilization of the gas, ammonia, benzol, and tar, a by-product plant includes not only the batteries of ovens, with their system of heating and the necessary ducts and mains, but also a recovery plant. First in importance in this system are the exhausters, which remove the gas from the ovens, draw it through the mains and cooling apparatus, force it through the scrubbing apparatus and deliver it to the combustion flues under pressure, or in case of rich gas, to the purifiers and storage gas holders. The control of the gas passing through the system centers in the exhauster room, and here is placed the gauge board on which are placed the pressure and vacuum gauges, which indicate the existing conditions in the various apparatuses. The exhauster is used because the slight pressure which is maintained in the ovens at all times, to prevent the leakage of air into them, is so variable that it would be unwise and undesirable to depend upon it to force the gas through the system.

First in order in the apparatus used in the treatment of the distillates come the air coolers, through which the gas is led to and fro in ascending zigzag passages, exposing large surfaces to atmospheric cooling. A number of these cooling units are arranged in parallel, so that any one of them may be taken off for cleaning or repairing without disturbing the operation of the remainder. They may be provided with an exterior sprinkling system, so that water cooling may be used in hot weather, when necessary, thus adding to the flexibility of the system. Next come the water coolers, which are rectangular in shape and filled with tubes to carry the water. The gas space is divided by successive baffles, so that a tortuous path is followed, and the circulating water is made to flow through the tubes in a parallel but opposite direction to the gas. After the gas has passed the air and water coolers, it is delivered by the exhauster to the tar scrubbers, where the tar which exists in finely divided particles in suspension in the gas, like a mist, is removed through friction and deposited in globules, by the passage of the gas through small openings in a series of thin steel diaphragms. When the coal yields considerable naphthalene which may plug these openings, other devices must be employed. After the tar scrubbers follow the ammonia scrubbers, which, in the tower type, contain a latticework of wooden slabs, over which the water trickles downward while the gases rise; and then come the purifiers, which are rectangular boxes, containing perforated trays holding layers of lime or Laming's mixture, by which the sulphur and carbon dioxide are removed from the illuminating gas. Then follows the ammonia-recovery plant, where the weak ammoniacal liquor is converted by distillation into concentrated crude liquor or into ammonium sulphate, and the benzol-recovery plant, where benzol is obtained from the lean gas by scrubbing it with dead oil. To these should be added the necessary gas holders, tar tanks, ammonia tanks, and other receptacles for holding the various materials and products, and sheds and appliances for storing and handling the coal used and coke produced.

Naturally, where the operations are conducted on so large a scale, it becomes possible to do by machinery much that in small plants is done by hand, and this is one of the economic advantages of the by-product plant. The mechanical appliances may perhaps be best referred to in a description of the method of operation.

Method of operating by-product ovens.—The coal is carried by conveyors from the storage pit to the storage bin above the battery of ovens, where it is drawn through chutes into the larry, which travels on rails over the top of the battery. The doors of an oven having been closed and the oven having been heated, the manholes in the top of the oven are uncovered and the larry brought over the oven, so that the coal in the larry may be discharged into it. Through an opening

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in one of the doors the charge is leveled by a leveling bar, the oven is then sealed up, and the valve leading to the gas main is opened. When the coking period has elapsed, the valves to the mains are closed, the doors on either end of the oven are removed, and the charge is forced out by a ram or pusher, which traverses the oven and pushes the coke out onto a wharf or into a car on the farther side of the oven, where it is quenched by a stream of water.

To obtain water cooling the coke in some cases is received in a specially devised quencher, which consists of a rectangular box with cast iron cellular walls. It is large enough to take in the whole oven charge and its bottom is formed of a motor-driven chain conveyor. The whole machine travels on rails parallel to the oven battery, and connection is made with the particular oven to be pushed by means of swinging doors and a drop bottom, which, assisted by the moving conveyor bottom, guides the coke charge to the conveyor. When the charge is received, the doors are closed and the coke is quenched with water. The immediate and violent generation of steam is taken care of by escape stacks. The whole receptacle is filled with steam, practically excluding the air, and the silvery gray color, characteristic of beehive coke, is thus obtained. When the quenching is complete, the coke is discharged into a car on the adjoining track.

The coal used in these ovens is fine coal, which not only facilitates charging but also permits the charge to pack closely, whereby the density of the resulting coke is improved. A modern practice in Europe for coals which had failed to produce a coke of sufficient density or strength is to compress the charge into a cake before loading it into the oven. In this case the coal is ground to the size of rice and moistened, so that it will cake slightly when compressed in the hand. It is then fed into a box somewhat narrower than the oven and stamped, layer by layer, by two or more stamps, which in some cases travel back and forth in the box and in others remain stationary while the box moves to and fro. When the box is full the coal has been compressed about 25 per cent. The box is now run onto a transfer car attached to the pusher, and then taken to the oven, where the sides of the box are removed and the coke pushed into the oven. The stamping of the coal prevents the formation of the spongy coke produced by certain coals and improves the physical structure as well. The process is not, however, advantageous for all coals, it being held that, when employed on coals which ordinarily produce a dense coke, the grain is made too close. A few installations for this method have been made in this country, but it has not as yet been generally adopted here.

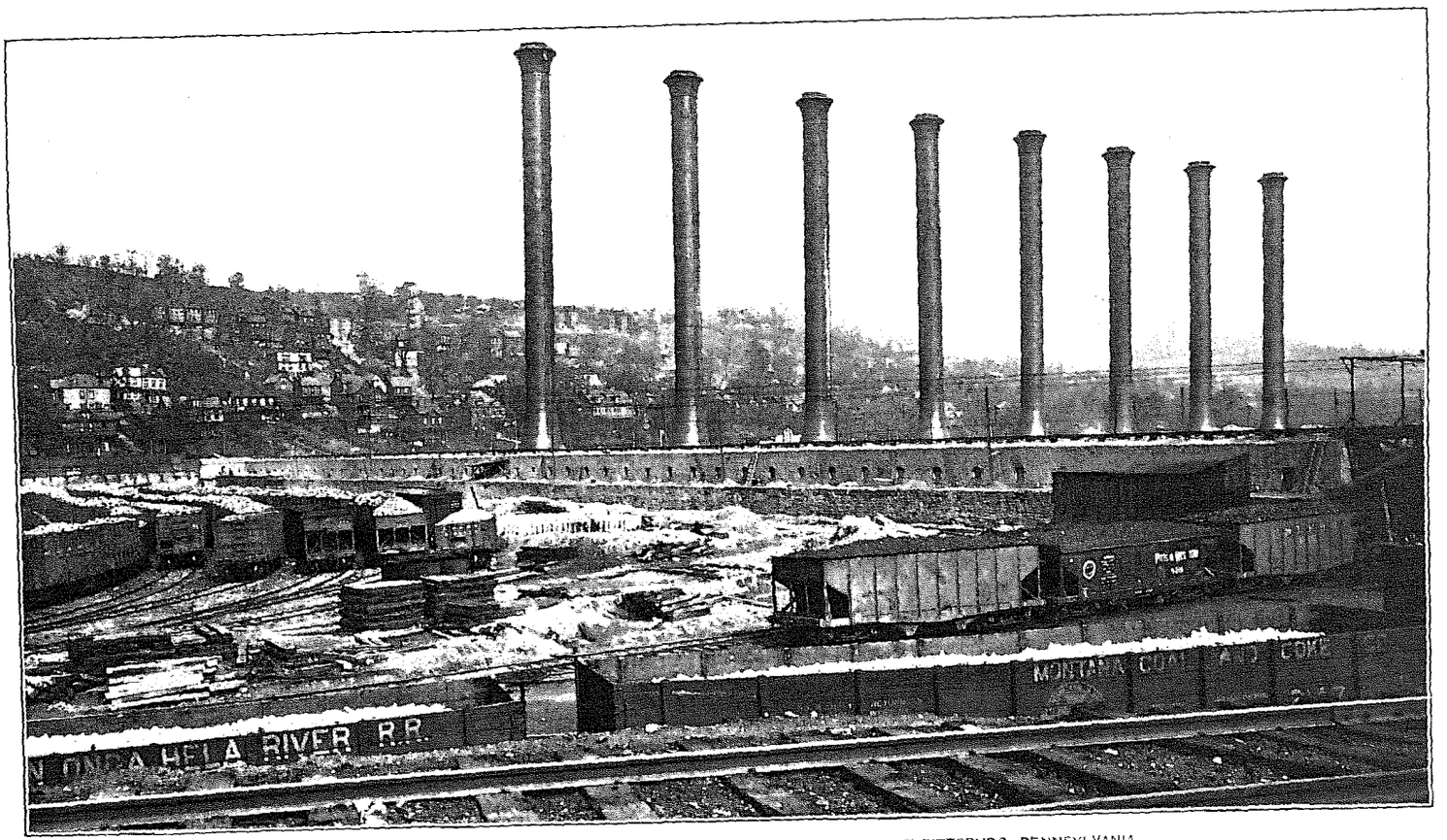
Semet-Solvay by-product ovens.—The first Semet-Solvay ovens, 6 in number, were built for experimental purposes in 1882, near Mons, Belgium, and the results were so satisfactory that their use spread. In 1892 a battery of 12 ovens was built at Syracuse, N. Y., to which shortly after 13 more were added. This was the first plant of by-product ovens erected in the United States, but by January, 1906, there had been built or were being built in the United States 13 plants of Semet-Solvay ovens, embracing 1,295 ovens. The locations of these plants, the number of ovens in each plant, the character of the coke produced, and the use to which the gas is put is shown in the following statement:

Semet-Solvay by-product ovens built or building in the United States, January, 1906.

LOCATION.	Number of ovens.	Kind of coke.	Use of gas.
Syracuse, N. Y.	40	Kiln, foundry	Fuel.
Dunbar, Pa.	110	Furnace	Fuel.
Sharon, Pa.	25	Furnace	Fuel.
Ensley, Ala.	240	Furnace	Fuel.
Wheeling, W. Va.	120	Furnace	Fuel.
Detroit, Mich.	120	Furnace, foundry, domestic	Illuminating.
Chester, Pa.	40	Domestic, foundry	Illuminating.
Tuscaloosa, Ala.	40	Furnace	Fuel.
Milwaukee, Wis.	160	Furnace, foundry, domestic	Illuminating.
Lebanon, Pa.	90	Furnace	Fuel.
Geneva, N. Y.	30	Foundry, domestic	Illuminating.
Chicago, Ill.	160	Furnace, foundry, domestic	Illuminating.
Steelton, Pa.	120	Furnace	Fuel.

As marking the progress it may be noted that in 1893 the standard block of Semet-Solvay ovens was 25 ovens, having a coal capacity of 4.4 short tons each, or a total of 110 tons; in 1903 the standard block was 40 ovens, having a coal capacity of 7 to 9 short tons each, or a maximum of 360 tons; and in 1905 the standard block was 80 ovens, having a coal capacity of 9 short tons each, or a total of 720 tons. The length of the ovens has increased from 30 to 35 feet, and the height from 5½ to 9 feet, but though greater widths have been tried, an average of 16½ inches has been found most advantageous. The number of flues in the side walls in 1893 was three, in 1903 four, and 1905 five, the ovens being consequently spoken of as three high, four high, or five high. The time required for the treatment of a charge in 1893 was twenty-six hours; in 1903 the average was twenty-four hours; in 1905 it was eighteen hours; the shortening of the time being attributed to the introduction of machinery for charging and discharging the ovens and to the use of higher heats. The entire operation of discharging, charging, and sealing up an oven does not now occupy over fifteen minutes.

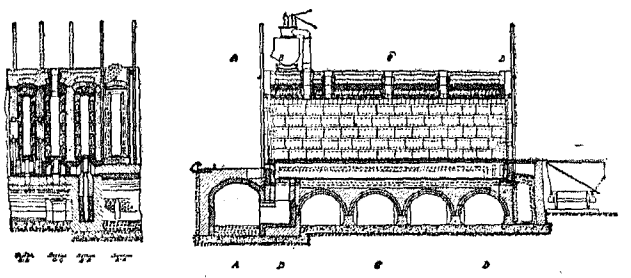
The Semet-Solvay system is distinguished by the use of horizontal flues formed either with small bricks or with hollow fire brick tiles; and by a special means for preheating the air for combustion, and sometimes the combustible gases also, by the waste gases of combustion. The hollow fire brick tiles are about 3 feet long and, placed end to end, they form the flues, while placed one on another, they form the facings of the side walls of the ovens. The flues are connected by an opening in the bottom placed near one end of each flue,



BEEHIVE OVENS OPERATED IN CONNECTION WITH LARGE STEEL PLANT AT PITTSBURG, PENNSYLVANIA.

so that gases and flames may traverse the entire length of all the flues. To heat the ovens, in a four high oven for instance, gas is admitted at the ends of three of the four flues and meets hot air from the recuperators below. The flame travels along the entire series of flues, from above downward, being reinforced at each point of gas supply until it reaches the bottom of the oven, and thus absolute control of the temperature at any point is obtained. At the bottom of the oven the currents of gases from the several flues meet, pass through a series of channels with thin walls, thereby preheating the air for the combustion of the gas above, and out to the chimney flue. On the way to the stack the gases pass through water-tube boilers where they raise part of the steam for operating the plant, although the temperature of the flue before the boilers is not above a dull red, and is often entirely black. Nevertheless, the volume of the gases is large and generates considerable steam. This utilization of the waste heat of the combustion gases effects a considerable economy, as a large volume of steam is required in the treatment of the ammoniacal liquors. The air for supporting the combustion is drawn in by a chimney draft through a

Longitudinal cross section of five high Semet-Solvay ovens.



flue, where it is heated to a temperature of from 200° to 500° C. by gases of combustion which pass out in the flue below the oven. The air is admitted to oven flues and regulated by dampers so nicely and the gas supply is under such control that combustion takes place with the minimum amount of air and the temperature of the flues may be maintained at will from 900° to 1,400° C.

The advantage claimed for the Semet-Solvay method of construction is that the hollow flues forming the walls of the oven are entirely independent of the side walls. These side walls, made of fire brick, carry the huge mass of brickwork, coal cars, etc., above the oven proper and thus relieve the flue-structure bricks from all strains and thrusts, which would have a tendency to displace them, causing leaks deleterious to the gas and other products. Because of the freedom from burden, the oven sides of the flues can be made much thinner than they otherwise could, so that they conduct the heat from the flue where the combustion of the gas takes place to the mass of coal in the oven more advantageously. The thick side walls and the mass of brickwork above serve to hold the heat, giving it up to the oven during the time of discharging and charging, thus preventing any chilling of the oven. An expansion space above the oven permits the tile to expand without affecting the main body of brickwork. Moreover, the horizontal arrangement of the flues and the admission of the gas at several points permit an easy control of the temperature of all parts of the coking chamber, and a ready inspection of the whole length of every flue to determine whether the temperatures are controlled and distributed properly. This point is of great importance, since it insures the whole mass of coal being thoroughly coked, and in the minimum time, without any danger of overheating any part of the oven structure. In fact, a uniform and accurately controlled temperature in the oven chamber is essential to the best coke in the shortest time.

Otto-Hoffmann by-product oven.—In 1881 the firm of Dr. C. Otto & Co. constructed and exploited in Germany an oven in which Siemens' regenerator was employed to recover the heat from the waste gases and to furnish heated air for combustion, the oven construction being of the Otto-Coppée type, then well known. This form of oven met with such acceptance that by 1894 over 1,200 of them had been constructed on the continent of Europe. In 1894 the first plant of this type was erected in the United States, a battery of 60 ovens being built for the Cambria Steel Company at Johnstown, Pa., to produce coke for use in its blast furnaces. This was therefore the first by-product oven plant operated in conjunction with a blast furnace in the United States. Since this date there has been a steady increase in the number of Otto-Hoffmann ovens, as is shown in the following statement:

Otto-Hoffmann by-product coke ovens built or contracted for in the United States: 1905.

LOCATION.	Number of ovens.	Use of coke.	Use of surplus gas.
Johnstown, Pa.	372	Blast furnace	Fuel and power.
Glassport, Pa.	120	Blast, domestic	Illuminating, fuel.
Everett, Mass.	400	Domestic, locomotive.	Illuminating, fuel.
Hamilton, Ohio	50	Foundry, domestic	Illuminating, power.
Lebanon, Pa.	232	Blast furnace	Fuel.
Buffalo, N. Y.	[1]564	Blast furnace	Fuel.
Camden, N. J.	100	Foundry, domestic	Illuminating, power.
Camden, N. J.	[1]50	Foundry, domestic	Illuminating, power.
Sparrow Point, Md.	280	Blast furnace	Illuminating.
Wyandotte, Mich.	15	Limekilns	Fuel.
Wyandotte, Mich.	[1]15	Limekilns	Fuel.
South Sharon, Pa.	212	Blast furnace	Fuel.
Duluth, Minn.	50	Blast furnace	Illuminating.

[1] Not completed.

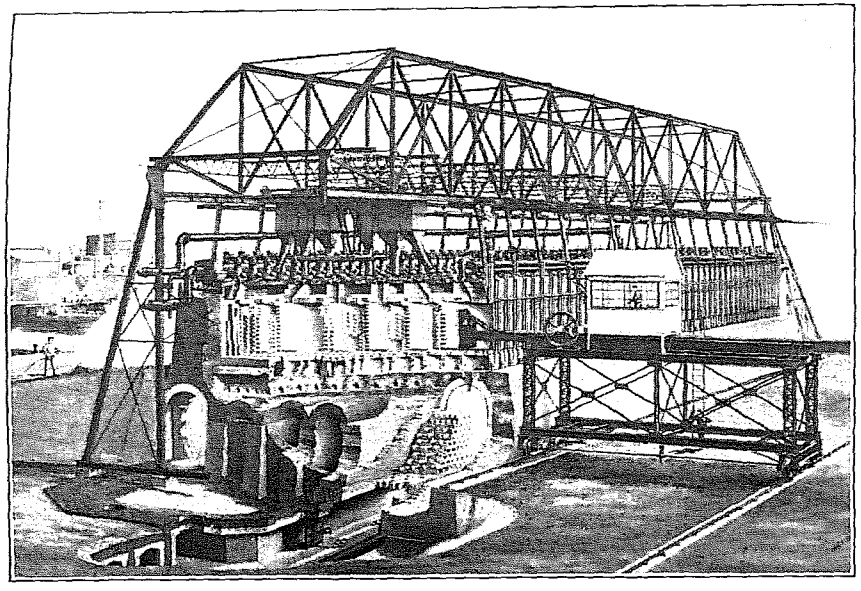
The Otto-Hoffmann system is distinguished by the use of vertical flues in the side walls of the ovens or retorts and the utilization of the Siemens' regenerator. The ovens or retorts of the usual rectangular form were built at first in batteries of 30 and later of 50. The ovens are 33 feet long, 6½ feet high, and from 17 to 22 inches wide, their capacity being from 6 to 7 net tons of coal. The walls of the ovens are sometimes built to

taper, so that the oven is wider at the discharging end than at the pushing end. This taper varies from 4 inches for swelling coals to 1 inch for those of a shrinking nature. The side walls are provided with vertical internal flues, through which the ovens or retorts are heated. The heating of the oven is done by gas, returned from the condensing house through lines running along each side of the battery, there being a burner at either end of each oven. Only one burner is used at a time. The air for combustion is taken in at the end of the battery where the gas and air reversing valves are located, and is led through underground passages to flues beneath the regenerative chambers. These chambers extend the whole length of the oven battery and are filled with checker brick. The air rising through this checker work is heated to a high degree and then passes through uptake connections to the space beneath the floor of the oven chambers, and thence through lateral ports to the combustion chamber, where it meets the gas from the burner. The burning gases rise through the vertical flues of half the oven wall, pass along the horizontal connecting flue above, and down the remaining vertical flues to the horizontal flues below, thence passing to the regenerator, where their sensible heat is absorbed by the checker work. From there they are led to the lower regenerator flue, past the reversing valve, to the draft stack. On the reversal of the air and gas the gas burner at the other end of the oven comes into use, the air passing up through the heated regenerator on that side to the gas burner and combustion chamber, the heated gases passing in the reverse direction through the wall flues, downward through the regenerator and so to the stack. The period of reversal is usually thirty minutes.

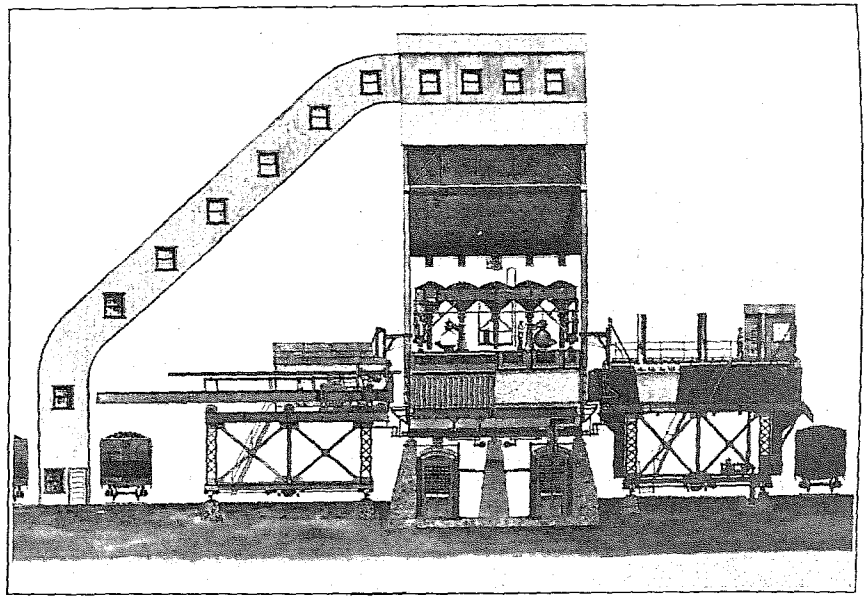
United-Otto by-product ovens.—The United Coke and Gas Company, in its work of erecting the Otto-Hoffmann plants in the United States, has modified the original design so much that it is now building a new oven, known as the United-Otto oven. The principal change involved is the adoption of the under-fired principle, which makes it possible to heat a longer retort of greater capacity than heretofore, and also makes each oven battery an economical unit without the use of an auxiliary steam boiler to absorb the heat from the combustion gases. The construction is described in the following statement, which was kindly supplied by this company:

> The oven itself is a rectangular retort from 33 to 43 feet long, 7 to 9 feet high, and 17 inches in width, the dimensions varying with the characteristics of the coal that is to be used. The retort walls, top and bottom, are composed of refractory material, and the masonry is supported on a steel and concrete substructure, so as to be entirely independent of the regenerative chambers below. This avoids the cracking of the oven walls and the consequent loss of gas, liable to occur from the expansion and contraction of the heated regenerator walls beneath the oven structure. Access is also given to all parts of the oven for inspection and incidental repairs. The open substructure admits of a complete anchoring system joining the buckstays above and below, and holding the oven walls securely in place. The steel work of the substructure is protected from the heated brick work above by a course of hollow tile, which also serves to retain the heat in the ovens. The oven chamber is closed at either end by doors, which are of the self-sealing type, replacing the older form of clay-luted doors. These do away with the labor of mixing and applying the luting clay, which has hitherto formed a large item in the operating expenses.
>
> The construction of the oven walls is a point of vital importance. Shaped brick of the best grade of refractory material of moderate size and simple design are used, complicated and irregular shapes and those of large size being avoided as being more liable to cracks and distortion. The time honored methods of laboriously chipping bricks of uneven thickness to form an even course in laying the oven walls has been abandoned entirely, and all cutting is done to exact dimensions by large carborundum grinding wheels, which economize the high-priced mason's labor and result in a quality of workmanship far beyond anything previously considered possible. This results in a practically gas tight wall of great strength.
>
> The resistance of the wall is enhanced by the vertical flue system, as the heating flues run perpendicularly along all that portion of the oven wall against which the coal can exert any pressure. The divisions between the flues form vertical strengthening ribs and tie the wall into a single homogeneous whole. This is of vital importance when coals of only slightly shrinking or even expanding nature are to be coked, such as are used at the Cambria plant. The greater unsupported wall areas necessarily exposed to the pressure exerted by this coal in a horizontal flue system is liable to result in bulging of the side walls and destruction of the oven. A great advantage of the vertical flue construction is its ability to withstand the compression loads due to the weight of the oven superstructure, thus doing away with the necessity of supporting walls built between the heating flue systems of each adjacent oven, and decreasing the cost of the masonry, as well as saving 33 per cent of the space required for a given block of ovens.
>
> The heating of the ovens is accomplished, as in the Otto-Hoffmann oven, by the use of gas returned from the condensing house. The air for combustion is supplied to the regenerator by a fan, this method aiding in the equal distribution of the air to each oven and reducing the amount of stack draft necessary. This not only allows the use of a smaller stack but makes a more even balance of the pressure in the flues and diminishes the loss of gas from an oven should a leak occur in the division wall. The gas is admitted through a burner at each end and four or six burners in the bottom, placed symmetrically on each side of the middle line. This avoids the use of bottom burners above the regenerative chambers, where they are less easy of access for cleaning and regulation. At the same time it makes it possible to heat properly ovens up to 43 feet in length, instead of 33 feet, which was the limit of the Otto-Hoffmann oven heated with the end burners alone. This results in an increase of oven capacity of approximately 50 per cent, and a corresponding saving in the operating cost per ton of output. The surface of the checker brick in the regenerators is so proportioned as to render the most efficient service in absorbing the heat from the waste gases, at the same time avoiding unnecessary cost in installation. The temperature of the waste gases leaving the regenerators is not high enough to cause deterioration of cast iron reversing valves of the usual form.

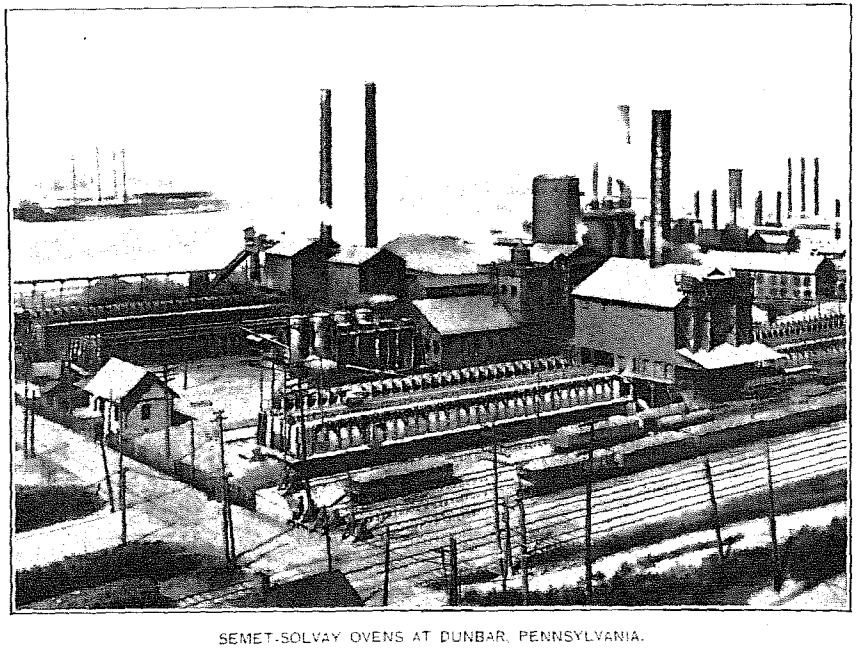
Rothberg oven.—The Rothberg oven consists of a long, narrow, rectangular coking chamber about 16 inches wide, 6 feet 4 inches high, and 33 feet long, closed at both ends with cast iron doors lined with brick. It is of the horizontal-flue type, one set of flues serving two adjacent ovens. In the center of the flue system is a vertical wall which divides it into separate parts. The oven, as built at Buffalo, has 5 horizontal combustion flues in each part, with a recuperator



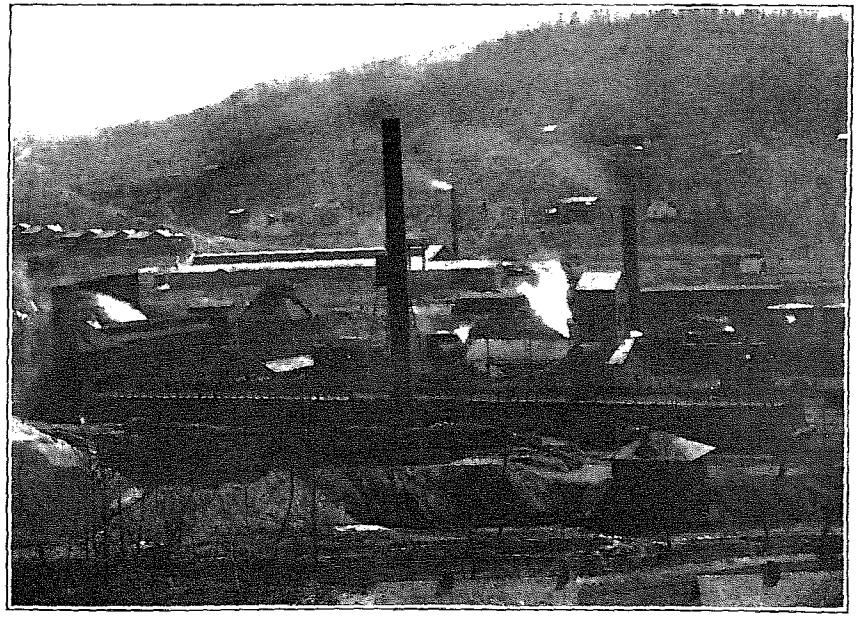
SECTIONAL VIEW OF OTTO-HOFFMAN OVEN.



SECTION OF UNITED-OTTO PLANT.



SEMET-SOLVAY OVENS AT DUNBAR, PENNSYLVANIA.



SEMET-SOLVAY OVENS AT WHEELING, WEST VIRGINIA.

flue for preheating the air above. At the end of each combustion flue is a burner connection for supplying gas and also a damper to regulate the amount of flame. The method of operation is as follows: Free air is admitted through openings in the top to the recuperator flue, where it is heated, and then it meets the gas at the end of the combustion flue; the flame then passes along the upper flue to the one below, continuing this zigzag course until the bottom flue is reached, when it passes through ports to the stack flue under the battery of ovens. From here it is led to the stack. This same operation is performed simultaneously at the other end of the oven, there being no reversals of the gas and air. In each port connecting with the stack flue is a damper by which the stack draft for any oven can be regulated. To maintain a uniform temperature in the flues, gas is admitted into the different flues through the burner connections in the front walls, and air can also be admitted through peepholes located near the burner connections. In the roof of the oven are openings for charging coal, and a single opening in the center passes off the gas, evolved during coking, to a gas collecting main on the top of the battery.

The ovens are arranged side by side in a battery of 47. At present there are two of these batteries in operation, and a third is ready for use. The ovens are charged with a compressed cake of coal, with a cross section slightly less than that of the oven and a length a few feet shorter, the cake being delivered to the oven in a charging box. When coked, it is pushed out of the oven by an electric pusher onto a quenching pan, and from there put into cars and taken away. There were 94 Rothberg ovens reported in operation in 1904 and 141 in the process of construction.

USES OF COKE.

While certain minor uses are found for coke, such as an acid-proof distributing medium in chemical works, or as a filtering medium, its most important use is as a fuel and reducing agent, and its greatest consumption is found in metallurgy. It is not a uniform product, but varies with the composition and physical condition of the coal from which it is produced and the manner in which it is made. It may be classified as follows: Metallurgical coke, which includes furnace coke and foundry coke; fuel or domestic coke, which includes egg, stove, and nut coke.

Furnace coke is designed for use in blast furnaces. It should be strong enough to resist the burden of the furnace, not so brittle that it crushes easily in handling in transportation or under the load of the furnace, sufficiently porous to permit the gases to permeate its mass, but so resistant that it may reach the zone of reduction in the furnace without any serious loss from reaction at incandescence with the carbon dioxide rising through the charge. Furnace coke is sometimes spoken of as 48-hour coke.

Foundry coke is used largely in cupola furnaces, and as it must there withstand the weight of the pig iron which is to be melted, it is a denser and stronger coke than that used in blast furnaces. Foundry coke is sometimes spoken of as 72-hour coke. According to Stammler,[1] "Coke for foundry use must be studied from various standpoints. If the cupola is of a low-tuyere type and long heats are taken off, a heavy coke is necessary to furnish sufficient fuel in small bulk to melt the metal and still hold the melting zone in proper position for economical work. Even should a light and strong coke hold the iron without crushing, it might not be possible to get enough of this coke in a low-tuyere cupola to melt the iron and retain the next charge at its proper height. On the other hand, a strong, light coke in a high-tuyere cupola is satisfactory and economical. It takes less coke to hold the iron at the proper melting zone, is more permeable to the blast, burns freer, and melts the iron faster than does heavy coke. Cokes should, therefore, be divided into two classes, and recommended according to their density, for high-tuyere or low-tuyere cupolas, as the coke is light or heavy."

According to Dewey,[2] "The credit of the first systematic investigation of the physical properties of coke belongs to John Fulton, mining engineer of the Cambria Iron Company." This investigation was begun in 1875, and it is now universally admitted that the physical characteristics determine largely the value of a coke. Fulton states[3] that the structure of coke consists of a series of irregular, promiscuously disposed cells, with vitreous walls, these cells being connected by diminutive passages that afford free courses for the oxidizing gases of the blast furnace. It is these hard, vitreous cell walls in coke that give it the superior value it possesses as an energetic fuel in blast furnaces. "From the foregoing it will be evident that the physical structure of coke, other things being equal, is the main element that confers on it the superior place it holds among blast furnace fuels. The same is true, in a modified way, of charcoal fuel. The anthracite holds the lowest rank." Thus the desirable ratio between the cellular space and the cell walls or body in a given volume of the coke has been carefully determined, and it is 43.73 per cent of body to 56.27 per cent of cellular walls. On the other hand, the chemical composition is of importance, as any impurities in the coke may enter the metal which is to be reduced or may form slag, and thus require a certain quantity of flux to prevent a waste of metal. It is well known that coal contains ash, sulphur or sulphur compounds, and phosphorus compounds, and these will be to a certain degree retained by the coke. A coke containing not more than 10 per cent of ash can be regarded as an average clean

[1] Report on Coal Testing Plant, Part III, page 1369.
[2] Trans. Am. Inst. Mining Eng., 1884, vol. 12, page 111.
[3] Coke, by John Fulton, 1905, page 329.

fuel, and those containing only 5 to 7 per cent of ash, as exceptionally pure. The sulphur in coke for use in metallurgical processes should be less than 1 per cent. The best coke contains only 0.5 to 0.75 per cent of this element. The purest varieties of coke contain from 0.012 to 0.029 per cent of phosphorus. Often as much as 40 per cent of the sulphur in the coal is volatilized in the coke oven, but as a rule all the phosphorus in the coal goes into the coke. Often a large part of the sulphur and some of the phosphorus may be removed by washing the coal before coking it. Domestic or fuel coke need not be so free from these foreign bodies and it may be denser and softer. In such a coke readiness in combustibility and, when hot, solubility in carbon dioxide gas are desirable, as, for instance, in producers when coke is used for making gas.

Besides being used in gas producers and water gas generators, coke is being largely used as a fuel for locomotives, especially in New England. It is also being crushed to size, screened and bagged for use as domestic fuel. According to the United Coke and Gas Company,[1] "Of the large output of the New England Gas and Coke Company, at Everett, Mass., some 200,000 gross tons per year are disposed of for domestic and industrial service, a similar amount being used for firing locomotives, particularly in suburban service, because of its smokeless nature. The same outlet has been found for the output of the Camden plant, a portion of which, however, is sold for foundry purposes." The fine coke, or braize, made in the handling and crushing of the coke is used directly under steam boilers, or it is made up into briquettes, although some is employed in lining steel furnaces. The amount and value of the coke consumed in each branch of the iron and steel industry, together with the per cent which this quantity forms of the total output, are given in Table 19 for each census year from 1880 to 1905.

[1] Short Treatise on the Destructive Distillation of Bituminous Coal, 1906, page 101.

TABLE 19.—QUANTITY AND COST OF COKE CONSUMED IN THE IRON AND STEEL INDUSTRY: 1880 TO 1905.

BRANCH OF INDUSTRY.	QUANTITY IN SHORT TONS.				COST.				PER CENT OF TOTAL PRODUCT.			
	1905	1900	1890	1880	1905	1900	1890	1880	1905	1900	1890	1880
All branches	20,378,452	17,682,072	9,797,353	2,315,560	$59,136,419	$40,991,400	$28,752,972	$8,743,382	81.0	90.0	97.9	84.1
Blast furnaces	19,739,676	16,755,489	9,402,898	2,166,260	57,127,027	38,976,770	27,435,780	8,129,240	78.5	85.3	94.0	78.7
Rolling mills and steel works	638,776	926,516	393,051	142,605	2,009,392	2,014,390	1,311,588	582,901	2.5	4.7	3.9	5.2
Forges and bloomeries	.....	67	1,404	6,695	.....	240	5,604	31,241	.....	(1)	(1)	0.2

[1] Less than one-tenth of 1 per cent.

From a table of statistics given by J. M. Swank,[1] showing the extent to which different fuels have been used in the United States for iron smelting, it appears that prior to 1855 charcoal was supreme, the quantity used exceeding that of either anthracite coal or coke, but in that year the consumption of anthracite exceeded that of charcoal; in 1869 the consumption of coke exceeded that of charcoal; in 1875 the consumption exceeded that of either charcoal or anthracite coal; in 1880 the consumption of coke exceeded that of both charcoal and anthracite combined, and this supremacy of coke has been maintained and extended ever since.

The account for the consumption of coke in the United States in the census year may be thus set forth:

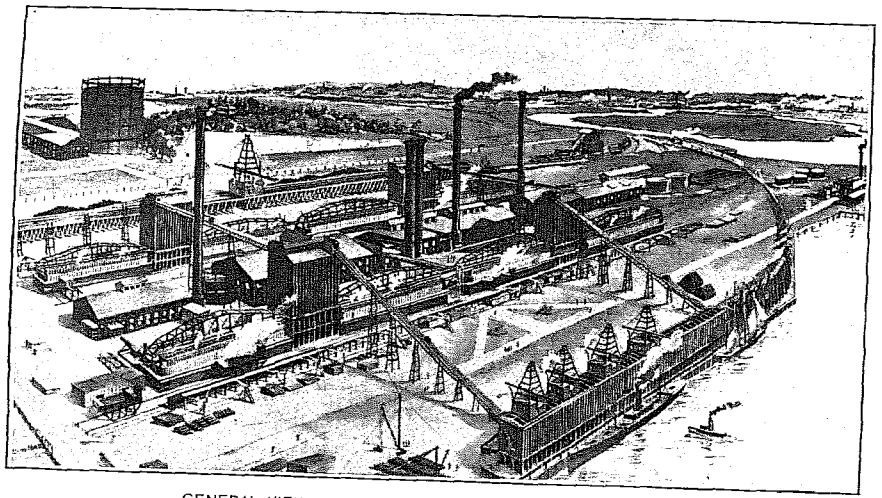
	Short tons.
Total	25,362,817
Coke produced	25,143,288
Coke imported	219,529
Total	25,362,817
Coke used in iron and steel industry	20,378,452
Coke exported	616,273
Coke used for all other purposes	4,368,092

USES OF BY-PRODUCTS.

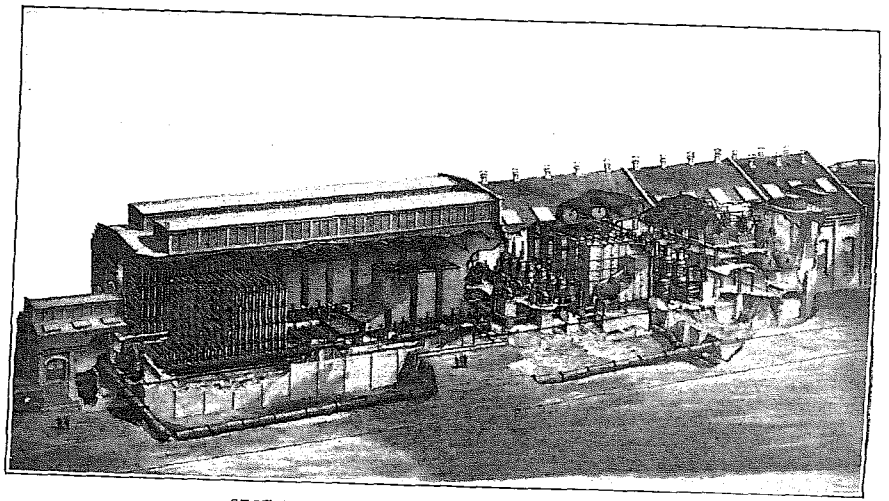
The ammoniacal liquor coming from the washers contains from 0.5 to 2 per cent of ammonia existing in a variety of compounds. It is so weak it must be further treated before it is marketable. On subjecting it to heat, part of this ammonia, known as free ammonia, comes off and may be collected in water. The rest may be liberated by heating the liquor with lime or some other alkali. The treatment then consists in distilling the liquor with lime and either collecting the distillate in sulphuric acid so as to form ammonium sulphate, or else condensing it with sufficient steam to form a strong liquor containing from 15 to 20 per cent of ammonia. The ammoniacal liquor from by-product coke ovens, gas works, boneblack factories, and blast furnaces is the chief source of the ammonia water, anhydrous ammonia used in refrigeration, and the ammonium compounds of commerce. Ammonium sulphate is used in the manufacture of alum and other compounds and as an ingredient of fertilizers. The quantity of ammonium sulphate reported as used in the present census year in fertilizers was 21,080,000 pounds. The total product of ammonium sulphate reported for that year was 31,546,763 pounds, and the amount imported 30,576,558 pounds, or a total of 62,123,321 pounds, so that but slightly over one-third of the available supply was consumed in the manufacture of fertilizers.

The tar which results from the dry distillation of coal

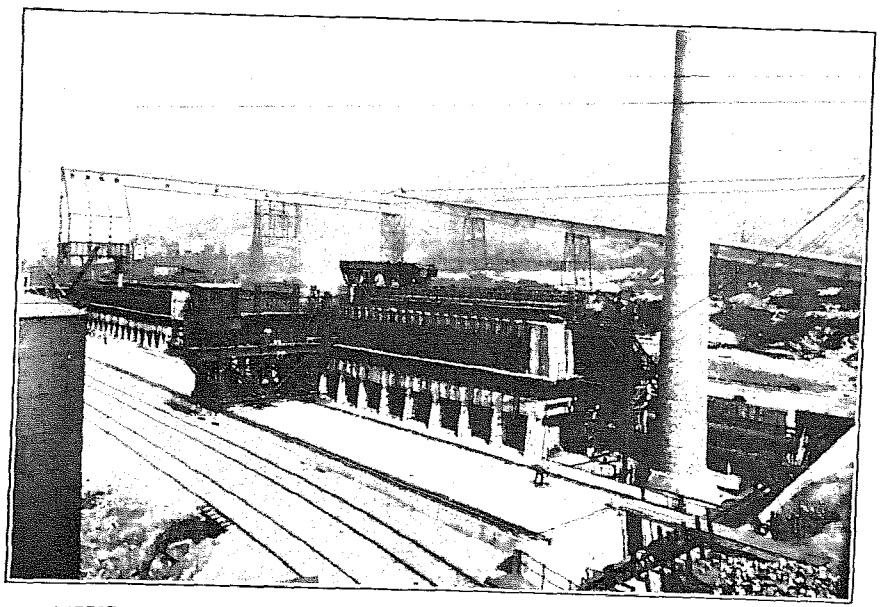
[1] Manufacture of Iron in All Ages, page 284.



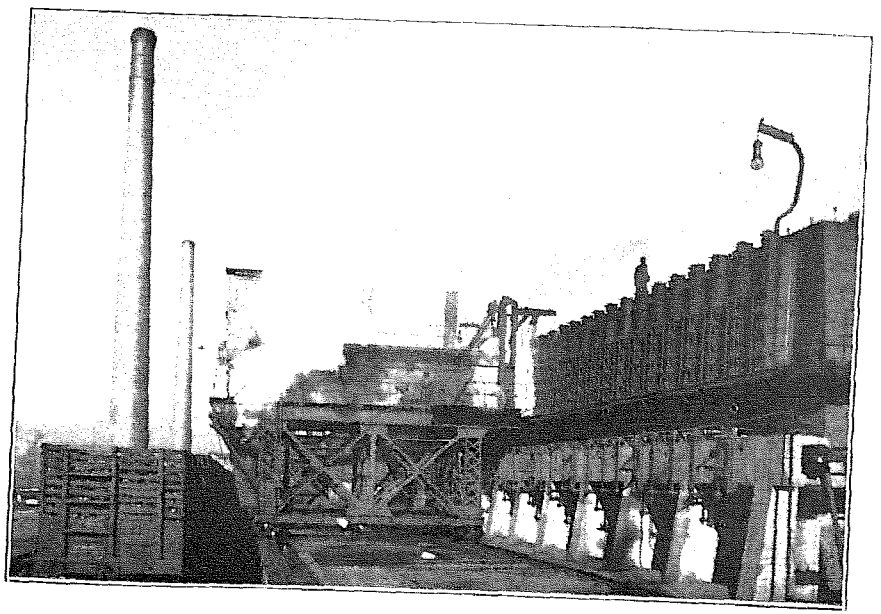
GENERAL VIEW OF PLANT AT EVERETT, MASSACHUSETTS.



SECTIONAL VIEW OF CONDENSING APPARATUS.



LATEST INSTALLATION OF 100 OVENS OF STEEL PLANT AT JOHNSTOWN, PENNSYLVANIA.



QUENCHER IN OPERATION.

is a mixture of a variety of hydrocarbons, amines, phenols, and other organic substances together with free carbon, and it varies both with the character of the coal treated and the manner in which it is treated. By-product coal tar differs from gas-house coal tar in that it contains only about 14 per cent of free carbon, while gas-house tar contains as much as 28 per cent. This is due to the much higher temperature of the gas retort, the greater rapidity with which the maximum temperature is attained, and the smaller charge used. The percentage of tar acids is also greater in gas-house tar than in coke-oven tar. The tar acids from coke-oven tar contain a high percentage of cresol, thus necessitating many distillations in order to produce pure phenol. Coal tar is the source of many organic substances, such as artificial dyestuffs and photographic and pharmaceutical chemicals. In the crude state it is used in making tarred paper, paint, and varnishes for coating bricks; and as a fuel, being equal, weight for weight, to crude petroleum in fuel value. Five pounds of tar are practically equal to from 7 to 8 pounds of coal. When heated to 250° C., to drive off the volatiles, coal tar pitch is produced, which is used in making tar macadam pavements, about 2 gallons being used per square yard of finished road. According to Pennock,[1] "As a consumer of tar, the tar macadam for 1903 will absorb 4,000,000 gallons, or the product of the dry distillation of 400,000 tons of coal." The tar macadam laid in the United States in 1901 by a single company was 14,400 square yards; in 1902, 440,000 square yards; laid and contracted for in 1903, 2,001,000 square yards, so that this industry is a constantly growing one. Coal tar pitch is also used for briquetting. In distilling the tar to obtain the pitch the distillate is divided into two portions—that which is lighter than water and that which is heavier. The light oil is redistilled for benzol and solvent naphtha. The heavy oil is in demand for creosoting timber. Two grades of pitch are usually made—paving pitch and roofing pitch.

The volume of gas evolved from a by-product oven is determined directly by the quantity of volatiles in the coal used and the heat applied. The quantity necessary to be returned to heat the ovens varies also with the coal. If the coal contains 32 to 34 per cent of volatile matter, from 50 to 55 per cent of the gas must be returned, but less gas suffices for those containing less volatile matter. The composition of the gas varies throughout the operation, it being richer in illuminants, methane, and carbon monoxide at the beginning. In separating the gas, in order to sell the surplus, the first runnings from 22 down to 14 candlepower are taken. This comes off on an average in the first ten hours of the operation. The rest of the gas, known as the lean gas, is that which is used in heating the coke ovens. Sometimes the benzol is removed from this lean gas and added to the surplus gas to enrich it—that is, to increase its candlepower. The benzol is removed by scrubbing the gas with tar oil, which dissolves it, and then recovering the hydrocarbon from the tar oil by fractional distillation. Gas from by-product plants is sent considerable distances. The plant at Everett, Mass., supplies Boston and the surrounding cities; from Sparrow Point, Md., the gas is pumped 11 miles to Baltimore; from the Camden, N. J., plant it is pumped 38 miles to Trenton; and the Duluth plant supplies the cities of Duluth and Superior.

[1] Loc. cit., page 788.

APPENDIX A.

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APPENDIX B.

DIGEST[1] OF PATENTS RELATING TO COKE.

This digest covers the patents included in the subclasses named in Class 202, Charcoal and Coke, of the United States Patent Office classification.

Some of the patents in these categories are quite foreign to the subject under consideration and many but indirectly related to it. On account of the form which discussions of patent issues often take, it has been thought better, however, to include these latter patents. The aim in making the digest has been to give such a sketch as will indicate the nature of the invention and what is claimed by the inventor, this generally being done by an actual abstract from or paraphrase of the words of the letters patent, but no responsibility is assumed for the opinions, theories, or claims tl us set forth. Other related patents may have been granted which do not appear in this digest, because they are not embraced in the subclasses enumerated. It is suggested that such patents may be found in the classes relating to illuminating gas, wood distillation, and similar topics.

CLASS 202.—CHARCOAL AND COKE.

CHARCOAL.

SUBCLASS 2.—PROCESSES.

720—April 28, 1838. MICHAEL CARROLL. *Improved mode of forming a kiln for making charcoal.*

Relates to the manner in which the logs are to be piled in forming the mound.

14,619—April 8, 1856. SANDFORD S. PERRY. *Improvement in charring wood.*

Claims the process or mode of charring wood, or, as it is commonly called, "burning charcoal," by the application of hot or heated air to the wood to be charred.

16,304—December 23, 1856. ANDREW GRIMES. *Improvement in burning charcoal.*

Claims burning wood in the open air without any covering of earth, or any substitute therefor, in such a manner as to reduce any given amount of wood to a mass of red-hot coals while preventing the pile from burning to ashes until this result is accomplished.

129,815—July 23, 1872. LEVEN S. GOODRICH. *Improvement in processes and apparatus for the manufacture of charcoal.*

Claims the process which consists of a variable air supply to carry on the process of wood charring by the combustion of the flammable gaseous products thereof, and to prevent the said air supply from coming in direct contact with the charcoal produced by the distillation of the wood by the said combustion.

196,714—October 30, 1877. LEVI STEVENS. *Improvement in coking coal and desulphurizing the coke.*

Claims the process of coking coal, which consists in passing the gases evolved from the coking coal contained in one chamber into and through the coke contained in an adjoining chamber, produced from a previous charge, and kept at a high temperature, whereby said coke takes up carbon from the hydrocarbon gases of the coking coal, and is thereby rendered compact and firm.

200,662—February 26, 1878. WILLIAM A. MILES. *Improvement in methods of operating charcoal kilns.*

Claims the method of operating charcoal kilns consisting, essentially, in first, preparing the kiln in the usual well-known manner and lighting the fire; second, closing tightly the usual opening or openings into the atmosphere; and, third, forcing air into the kiln in a series of equal or unequal jets and out of the same with the products of distillation in another series of jets to the condenser.

211,376—January 14, 1879. HORACE L. BROOKE. *Improvement in plants and processes for the manufacture of charcoal and pyroligneous acid.*

Claims the process of manufacturing charcoal and pyroligneous acid, consisting in forcing into a charcoal kiln a quantity of air sufficient to support combustion of a part of its contents, and thereby char the rest, and condensing and recovering the pyroligneous acid and vapors.

249,366—November 8, 1881. JOSHUA KIDD. *Charring oven.*

Claims the improvement in the method of charring substances which consists in passing the products of combustion through a fresh charge of material for charring the latter and depriving the products of combustion of a large proportion of their heat, and then passing the same in their lowered temperature through a charge of material which has been previously charred for expediting the cooling thereof.

272,376—February 27, 1883. HENRY M. PIERCE. *Process of manufacturing charcoal.*

Claims in the manufacture of charcoal, the method of conducting the carbonizing process, which consists in admitting the air supply at or near the center and base of the charge, firing the charge at or near the top thereof, and withdrawing the gases and vapors from the base and circumference of the charge.

278,781—June 5, 1883. HENRY M. PIERCE. *Manufacture of charcoal.*

Claims as an improvement in the manufacture of charcoal or coke the method for cooling the contents of the kiln, consisting in maintaining a circulation through the kiln of a noncombining gas—such as carbonic oxide or carbonic acid, said gas being maintained at a lower temperature than the kiln and its circulation continued after the fire has been extinguished and until the contents of the kiln have been reduced to a low temperature; and,

The method of extinguishing the fire of a charcoal kiln or like chamber and cooling the charge thereof, which consists in cooling the carbonic acid gas generated from the burning or carbonizing mass contained in the kiln and then forcing it into the kiln and into and among the charge.

284,058—August 28, 1883. HENRY M. PIERCE. *Method of distilling and charring wood and kiln therefor.*

Claims the method of distilling and charring wood, which consists in firing the charge and withdrawing the moist volatile products from the top of the charge, and condensing liquefiable portions, then closing the discharge pipe at the top of the kiln and withdrawing the gases down through the charge to the bottom of the kiln, condensing the liquefiable portions thereof, and forcing the uncondensed gases by a steam-jet ejector to a furnace for combustion.

284,059—August 28, 1883. HENRY M. PIERCE. *Process of manufacturing charcoal and kiln therefor.*

Claims the method of manufacturing charcoal, which consists in charging the kiln with wood laid in reticulated form and with flues extending from bottom to top of the kiln, firing the charge, and admitting jets of steam or other gaseous fluid into the flues, and thereby causing a circulation of the heat and gaseous products through all the interstices of the charge, whereby it is rapidly and uniformly heated and reduced to charcoal of even quality.

309,874—December 30, 1884. HENRY M. PIERCE. *Method of and apparatus for treating wood for the manufacture of charcoal.*

Claims the method of preparing woods for carbonization, which consists in permitting the condensable vapors of an initial charge to escape directly into the open air, or into a condenser, and then passing the light, highly heated gases given off toward the close of carbonization or distillation through the fresh charge to be treated.

326,452—September 15, 1885. HENRY M. PIERCE. *Process of utilizing wood gases for metallurgical purposes.*

Claims in a blast furnace the process of utilizing the gases evolved in the destructive distillation of wood as fuel, which consists in first conducting the wood gases to a condenser and reducing to liquid their condensable constituents, then forcing the uncondensable gases into a heating chamber which is heated by the waste gases from the said blast furnace, then mixing a suitable quantity of atmospheric air with said wood gases, and then injecting the whole into a blast furnace.

345,151—July 6, 1886. LEVEN S. GOODRICH. *Process of manufacturing charcoal.*

Claims in charcoal making, the process which consists in arresting and storing the noninflammable gases resulting from the carbonizing process, and at the completion of the latter returning said gases to the kiln under pressure greater than that of the external atmosphere, and maintaining such pressure within the kiln until the cooling of the latter is effected.

[1] Copies of these patents may be obtained upon application to the United States Commissioner of Patents, Washington, D. C., at a cost of 5 cents each.

466,265—December 29, 1891. LEOPOLD ZWILLINGER. *Process of and apparatus for making charcoal.*

Claims in the manufacture of charcoal, the improvement which consists in placing the material in a retort, and means substantially such as described for heating the same, applying heat to the latter, and passing through the material in the retort superheated air substantially free from oxygen and combined with steam by first passing the air through water for the purpose of eliminating the oxygen and combining the air with moisture, and then superheating the moisture laden air.

477,875—June 28, 1892. ALBERT VICKERS. *Method of arresting and extinguishing combustion in charcoal kilns.*

Claims the method of arresting and extinguishing combustion in charcoal kilns, which consists in introducing into the kiln, after firing has reached the desired point, sulphuric acid or like liquid decomposable into noncombustible gases under the action of the heat and carbon present and causing the said generated gases to circulate continuously through the charcoal from top to bottom of the kiln.

607,231—July 12, 1898. JOSEPH BERRY. *Charcoal kiln.*

Claims a charcoal kiln consisting of a foundation of longitudinally laid sticks, a V-shaped space formed by the arrangement of sticks at the front portion of the kiln, a series of draft spaces formed around the edge of the kiln by overlapping the ends thereof, and a superstructure composed of cord wood built thereon.

705,215—July 22, 1902. OSCAR DAUBE. *Method of carbonizing organic materials.*

Claims the method of carbonizing organic material and material of organic origin which consists in mixing 66⅔ per cent air under a constant pressure of from 5 to 8 pounds and 33⅓ per cent highly nitrogenous gas; passing the resultant gas through a coal fire, reducing the temperature of the gas issuing from the fire to from 400° to 600° Fahrenheit, subjecting the material to be carbonized to said last mentioned gas at the said temperature of from 400° to 600° Fahrenheit, and under the said pressure still constantly maintained, and exhausting the gases emanating from said material during carbonization immediately they free themselves.

705,926—July 29, 1902. JOSEPH HEMINGWAY. *Continuous process of coking coal.*

Claims the continuous process of making metallurgical coke which consists in pulverizing bituminous or semibituminous coal, mixing it with about 4 per cent of boiling hot water, mixing the moistened mass with about 10 per cent of coal tar, charging the coking ovens with said mixture, distilling it, and returning the heavy portion of the distillate, containing tar, pitch, and similar substances (mixed with a fresh charge of coal moistened with hot water) into the coking ovens during the coking operation.

711,905—October 21, 1902. THADDEUS S. C. LOWE. *Process of manufacturing coke.*

Claims in the manufacture of coke the process of continuously and progressively converting the charge into coke and intermittently recovering gas from the charge while being coked, which consists in alternately raising the temperature of the oven arches to above the temperature required for coking, and then introducing steam at or above its decomposable temperature into the upper parts of the ovens and above the body of the charge with reference to effecting the recombination of the elements of the steam and the otherwise waste gas evolved in coking into a fixed recoverable gas.

744,669—November 17, 1903. BERNHARD ZWILLINGER. *Process of carbonizing and cooling down the charge.*

Claims the process of producing carbonized substances which consists in initially carbonizing the said substances and subsequently, while the charge is still hot, continuously subjecting it to the action of mechanically propelled cooled gases free of uncombined oxygen in a greater quantity than the capacity of the carbonized substances for absorption after cooling and at atmospheric pressure, whereby the charge may be cooled down in a rapid and efficient manner.

744,670—November 17, 1903. BERNHARD ZWILLINGER. *Process of carbonizing material.*

Claims the process of carbonization which consists in preliminarily deoxygenizing atmospheric air, heating the resultant gas to such a temperature as to effect the carbonization of the carbonizable material in the kiln at a temperature not exceeding 800° Fahrenheit, and acting upon the said material with the said heated gas, removing the products of carbonization, and thereupon continuing the carbonization by heating and circulating the said products of carbonization through the kiln so as to effect the carbonization at a temperature not exceeding 800° Fahrenheit.

794,481—July 11, 1905. DAVID M. BALCH. *Process of manufacturing fuel from seaweeds.*

Claims the process of treating seaweed to obtain fuel consisting in drying the weed, then coating the weed with an alkaline substance prior to further treatment, then subjecting the dried and alkaline-coated weed to the indirect action of dry heat immediately subsequent to coating the weed with the alkaline and until the volatile products are driven off and a char results, then lixiviating the charred residuum with water until the saline constituents of the residuum are removed, and subsequently drying the residuum.

SUBCLASS 3.—RETORTS.

8,492—November 4, 1851. W. P. McCONNELL. *Improvement in the manufacture of charcoal.*

Claims an iron cylinder with a double bottom, the upper one being perforated, and these combined with several flues covered at the top with dampers and protected within with iron rings, the whole so constructed that the fire may be applied either on the top, under the bottom, or within the flues, or in all together, at pleasure.

96,649—November 9, 1869. JOHN ADAMS. *Improved apparatus for carbonizing peat.*

The invention consists in carbonizing peat for making into marking ink and other useful products, by heating the peat in retorts set in a furnace and connected with a steam boiler, so that when carbonization is attained the fire may be extinguished by the steam.

184,963—December 5, 1876. GEORGE L. HARRISON, JR. *Improvement in processes and apparatus for the manufacture of charbon-roux.*

Claims the process of making charbon-roux which consists in subjecting billets of wood to heat under agitation, and the combination of a retort having a removable head plate, and pipe, with a revolving cage and furnace.

197,942—December 11, 1877. MOSES NICHOLS. *Improvement in retorts for making gunpowder charcoal.*

The object of this invention is to provide a retort and furnace for making charcoal for the manufacture of gunpowder and for the distillation of pyroligneous acids for medicinal and chemical purposes of more uniform quality than has hitherto been produced from retorts as ordinarily constructed, owing to the uneven application of the heat from the furnace, whereby the outer portions of the contents of the retort are generally burned too much, while the interior is not sufficiently burned, resulting in a loss of wood and a variable quality of charcoal unfit for the particular purpose designed; and it consists in a novel arrangement of flues and diaphragms both around and within the retort; also in provision for extracting and preserving the acids evolved during the process of burning.

276,222—April 24, 1883. JOHN BURT. *Charcoal furnace.*

Claims in an oblong charcoal furnace the combination of a removable heating chamber arranged in said furnace, forming retort chambers, the floors of which overhang the front and rear of the fire chamber and incline from the centrally located heating chamber to the front and rear to form the top of the front and rear ends of the fire chamber.

283,643—August 21, 1883. CHARLES S. NELLIS. *Charcoal kiln.*

Claims the combination of the retorts having a combustion chamber extending through it, horizontal flues communicating at each end with the chimney and connected with the combustion chambers, respectively, at the upper and lower end of the retorts, vertical flues connecting the horizontal flues intermediately between the retorts, and dampers in the horizontal flues intermediately between the vertical flues and combustion chambers at each side thereof.

287,817—August 14, 1883. JACOB SCHERFFIUS. *Apparatus for the manufacture of charcoal.*

Claims in an apparatus for producing charcoal, the combination, with a fire chamber, of a charring chamber, a jacket surrounding said charring chamber, a space, however, being left between the walls of the charring chamber and the walls of the jacket, tubes or pipes connecting the outlet of the fire chamber with the space between the walls of the charring chamber and its jacket, valves or dampers arranged in connection with said tubes, a smoke pipe leading from said space between the charring chamber and its jacket, and a branch smoke pipe provided with a damper, which said branch smoke pipe leads from the discharge opening of the fire chamber to the main smoke pipe.

407,166—July 16, 1889. FRANKLIN S. CLARK. *Retort for distilling wood and making charcoal.*

Claims in a wood-distilling apparatus, a furnace, combined with the stationary outer cylinder, arranged within the furnace, and a removable inner cylinder to contain the wood and having openings in its sides, said inner cylinder being smaller than the outer cylinder and arranged within the latter, so as to provide an air space around the inner cylinder, with which air space the openings communicate, and doors on the inner cylinder for closing the openings, said doors being carried by the inner removable cylinder when it is drawn out.

409,878—August 27, 1889. JACOB SCHERFFIUS. *Charcoal apparatus.*

Claims the combination, with fire and charring chambers, of a dampered pipe extending from the former into the latter, chambers surrounding both the fire and charring chambers, communication being established between the fire chamber and the chamber surrounding the charring chamber and between the latter and the chamber surrounding the fire chamber, and condensing pipes connecting the charring chamber and the chamber surrounding the fire chamber.

682,313—September 10, 1901. BERNHARD ZWILLINGER. *Apparatus for carbonizing material.*

Claims the combination, with a carbonizing chamber, having its lateral walls made hollow to form a flue extending nearly around the chamber, of a chimney leading from one end of said flue, and a superheating furnace discharging its waste gases into the opposite end of said flue, whereby the chamber is practically surrounded by a constantly renewed layer of heated gas, and means for passing gas through said superheating furnace and into the carbonizing chamber.

687,304—November 26, 1901. GUSTAF GRÖNDAL. *Apparatus for charring wood, etc.*

Claims the process of continuously carbonizing or charring wood and the like, consisting of passing the wood through a furnace, causing a gas indifferent to red-hot coals to enter the furnace at a point where the coals are incandescent, thereby heating the gas and cooling the coals, passing said heated gas around a charring muffle, but not in contact with the wood therein, admitting air to the gas at this point to cause combustion to char the wood in the muffle, and causing the burned air and gas to heat the wood preliminary to its reception into the muffle.

701,145—May 27, 1902. CHARLES J. T. BURCEY. *Apparatus for manufacturing charcoal.*

Claims an apparatus for manufacturing charcoal comprising a combustion chamber, a receiving chamber for the wood to be charred, a main heat conducting passage communicating with the combustion chamber, a plurality of passages communicating independently with the main heat conducting passage and also communicating independently with the atmosphere, said passages being each provided with an inclosing wall for preventing the escape of the products of combustion from the passages into the interior of the receiving chamber, and means for controlling the flow of the products of combustion from the combustion chamber and the main heat conducting passage to the atmosphere through said plurality of passages independently, and thereby rendering substantially uniform the treatment of the wood in the different portions of the interior of the receiving chamber.

731,059—June 16, 1903. PER LORENTZ LAURELL. *Retort for carbonizing wood or the like.*

Claims a carbonizer comprising a retort having a central open-ended flue, a casing, a source of heat supply on one side and at the foot thereof, a support for the retort in said casing inclining downwardly to the opposite side, flues below said support provided with cut-off devices and diverging from the source of heat supply and leading to a central space in communication with the flue of the retort, an air flue opposite the source of heat supply, provided with a cut-off device and leading also to said central space, a pipe provided with a vertical branch in said air flue and connected with the retort at its lowest point, and a stack in communication with the space about the retort substantially at the lowest point of its support.

744,700—November 17, 1903. ALONZO T. WILSON. *Charcoal or coke oven.*

Claims an oven for making charcoal and coke comprising a front wall having a doorway, a rear wall having horizontal flues, a chimney connected with said flues, an arched wall and roof closed from top to bottom and from front to rear, a closed floor, furnaces in the front wall under the floor and communicating with an open space under the floor and combustion chamber extending rearward from the front wall and upward from the furnaces and provided with apertures communicating with the chamber above the floor.

777,415—December 13, 1904. WERTHER ANDERS GUSTAF VON HEIDENSTAM. *Apparatus for charring wood refuse or the like.*

Claims the combination, with a charring retort for wood refuse, peat, or the like, of a plunger, guide rods provided with a bottom plate and guide plates adapted to divide the material into sections while being charred, and a hood inclosing said guide rods, guide plates, and charring material.

790,103—August 1, 1905. JOHAN EMANUEL ÅSLIN. *Charring retort.*

Claims in a charring kiln a substantially cylindrical retort having a pair of separate furnaces at the front, a flue leading from each furnace through the outer walls of the retort to the rear portion of the furnace, upwardly extending passages communicating with the rear portions of said flues, a valve in each said flue adjacent its rear extremity, a flue extending across the bottom of the retort and leading from each said furnace and opening into the rear portion of each said flue, a valve arranged at the portion of each said latter flue adjacent the furnace, and a valve arranged at the other extremity of each said latter flue.

804,289—November 14, 1905. THEODOR LEDERMÜLLER. *Apparatus for carbonizing peat.*

Claims in an apparatus for carbonizing peat, the combination, with a heating oven, of a press adapted to contain the peat and mounted in the oven in a position to be exposed to the gases from the fireplace of the oven, a series of press plates arranged in said press and adapted to receive molding boxes between them and means permitting the introduction of molding boxes between said press plates without their traversing the fireplace of the oven.

SUBCLASS 10.—KILNS.

5,722—August 22, 1848. A. H. TAIT. *Improvement in coking wood by the waste heat of iron furnaces.*

Claims the application of waste or escape heat from forge or furnace fires making iron to the purpose of coking wood by radiation from flues constructed of iron or any other suitable material and in the same process of coking by waste or escape heat to extract from the wood pyroligneous acid, the flues being so arranged in connection with walls or piers as to prevent the wood from coming in contact with or resting upon said flues or pipes, by which means the atmospheric air is excluded and that portion of the wood consumed by the old process in coking the remainder converted into charcoal.

36,090—August 5, 1862. CHARLES T. HARVEY. *Improvement in charcoal kilns.*

The object of this invention is to combine a kiln for the manufacture of charcoal, so as to secure portability, exclusion of air, strength, and durability in a novel and useful manner. To do this, construct an outer shell or covering of convenient form and size, of metal divided into convenient segments, sections, or parts, composed of one or more sheets of metal and prepared with bolts or other fastenings, so that when each segment or part is placed in position it can be securely fastened to and with other segments or parts, so as to form, collectively, a complete metallic kiln, covering, or outer shell strong and durable. Then lay upon the inside a thin wall of brick or stone, having a space left between it and the metallic covering. Then fill in the space between the masonry lining and metallic covering with cement or grout formed of fire clay or other fluid mortar hardening in due time, which, when accomplished, renders the kiln complete and ready for use.

56,528—July 24, 1866. K. S. CHAFFEE. *Improved apparatus for making charcoal.*

This invention relates to a charcoal kiln provided with means for condensing pyroligneous acid from the smoke and volatile products resulting from a charge when in combustion within such kiln instead of being heated from outside, and the inventor—

Claims the application of a condenser to a kiln by extending such condenser as a pipe around the kiln and supporting it by means of series of branch pipes leading from it into the kiln, and combining with such condenser a discharge pipe to extend from it.

71,383—November 26, 1867. WILLIAM H. GUIGNON AND WILLIAM D. McDONALD. *Improvement in kilns for charring wood, etc.*

Claims a kiln for charring or carbonizing wood or coal, which is self-acting or automatic in its operation, and a portable kiln for carbonizing wood or coal, which is formed of a double wall, or an outer and an inner shell, whereby the heat is confined in the kiln.

78,264—May 26, 1868. MORTON E. CONVERSE AND ABEL T. ATHERTON. *Improvement in the manufacture of pyroligneous acid.*

Claims the application and arrangement of the flue tubes in one or more rows, to a kiln in such a manner that they will conduct, carry off, and save, the products of destructive distillation of wood.

129,814—July 23, 1872. LEVEN S. GOODRICH. *Improvement in apparatus for the manufacture of charcoal.*

The object of this invention is to produce an apparatus for the manufacture of charcoal which will save all the useful products arising from the distillation of the wood and at the same time increase the quantity and improve the quality of charcoal produced from any given amount of wood, and it consists in constructing a stationary kiln or furnace of any suitable size to contain about one-half of the wood to make a desired charge, covering the said kiln with a telescopic bottomless holder, which reciprocates vertically in an annular chamber surrounding said kiln, provided with a suitable liquid for sealing the same, like that of an ordinary gas holder. Said holder rises high enough to form a chamber between its top and the bottom of the kiln of sufficient dimensions to receive an amount of wood to make the desired charge, thus making up for the deficient capacity of the kiln itself, which is only designed to hold about half of said charge. At or near the top of said holder is situated a suitable number of doors, through which the kiln may be charged to avoid the necessity of removing the said holder for that purpose. Near these doors is situated a pipe or pipes for carrying off the products of distillation. The bottom of the kiln is provided with an arch, to which access may be had for regulating the air supply, which enters the kiln through orifices in said arch.

163,700—May 25, 1875. WARREN SPARROW. *Improvement in charcoal kilns.*

Claims a sectional charcoal kiln for the dry distillation of wood, composed entirely of thin metal sheets, which are formed into sections and adapted to be placed on and combined with a perforated foundation of stone.

178,855—June 20, 1876. BART KANE. *Improvement in charcoal kilns.*

Claims a kiln for making charcoal, of conical shape, with air-tight top, doors at base and midway up, and holes around its base.

226,207—March 9, 1880. WILLIAM A. MILES. *Charcoal kiln.* (*Reissue 10,746, July 20, 1886.*)

This invention covers a by-product kiln in which the gases generated are recovered and used in the further carbonization of the wood under treatment.

243,301—June 21, 1881. HENRY M. PIERCE. *Manufacture of charcoal.*

The invention relates to the utilization of the noncondensable and uncondensed gases and vapors given off in the carbonization of wood for the purpose of charring the wood, and has for its object to economize fuel and obtain a larger yield of charcoal from the kiln; and,

Claims the combination, with a closed charcoal kiln, of a weighted or automatic vent valve or valves, a valved eduction pipe, an induction pipe, and an interposed fan.

243,302—June 21, 1881. HENRY M. PIERCE. *Automatic cooler for kilns.*

This invention has for its object to save time and labor, to increase the working capacity of the apparatus employed, and consequently to reduce the capital required for various manufacturing purposes, such as the manufacture of charcoal, lime, and the like, or wherever the contents of kilns, furnaces, and heating chambers are preferably or necessarily cooled out of contact with the air; and,

Claims the combination, with a kiln, furnace, or heating chamber, of an eduction pipe leading from, at, or near the upper part of the kiln, a cooler located above the level of the kiln or furnace, and an induction pipe leading from the cooler to the kiln, whereby an automatic circulation of a cooling gas through the kiln or furnace can be established and maintained.

266,850—October 31, 1882. WALTER A. LOVELACE. *Charcoal kiln.*

This invention relates to that class of charcoal kilns in which the kiln consists of a hood adapted to be seated upon a foundation and provided with a door and with smoke and steam escape pipes; and,

Claims the combination of a kiln hood with its foundation provided with an inclosed centrally located fireplace, hot-air flues for conducting the hot air from the fireplace into the kiln, and smoke and steam escape flues for conducting smoke and steam through the foundation from the kiln to the external atmosphere when the hood is closed.

272,766—February 20, 1883. HENRY M. PIERCE. *Charcoal kiln.*

Claims a charcoal kiln having one or more transverse pendent partitions which divide the upper portion of the kiln into a series of separate chambers and having its floor made up of inclines whose lowest points are beneath the transverse pendent partitions.

292,635—January 29, 1884. JOHN A. EDWARDS. *Charcoal oven.*

Claims a conical metallic charcoal oven adapted to rest on the ground, in combination with corner posts and hoisting ropes.

307,928—November 11, 1884. JOHN A. EDWARDS. *Charcoal oven.*

Claims a charcoal furnace composed of sheets of metal, the sheets of the upper course being lapped outside the edges of the lower, whereby the joint is made automatically air tight in use.

326,451—September 15, 1885. HENRY M. PIERCE. *Apparatus for utilizing wood gases.*

The object of this invention is to provide means, in combination with a blast furnace, whereby the gases evolved in the destructive distillation of wood, together with some fixed fuel—such as charcoal, coke, or coal—may be utilized for the reduction of ores; and,

Claims, in an apparatus for utilizing wood gases for metallurgical purposes, the combination of a charcoal kiln, pipes leading therefrom, a heating chamber through which said pipes pass, a blast furnace to which said pipes lead, and a second pipe leading from the blast furnace to the heating chamber, whereby the spent gases from the furnace are utilized to heat the heating chamber and wood gases.

327,804—October 6, 1885. WALTER A. LOVELACE. *Charcoal kiln.*

Claims, in a charcoal kiln, the combination, with a central underground fireplace, having a grate, and a horizontal underground draft-flue, extending from beneath said fireplace to a point outside the kiln, of a portable dome-shaped hood, composed of a single thickness of iron plates, and having doors, a series of lateral openings, near the bottom, and a circular opening at the top closed by a cap.

342,201—May 18, 1886. LEVEN S. GOODRICH. *Apparatus for the manufacture of charcoal.*

Claims a kiln for the production of charcoal having an annular flue below its floor, openings through the floor connecting said flue with the interior of the kiln, a central chamber surrounded by said annular flue and communicating with the latter through suitable openings in the dividing wall, and a pipe extending from said central chamber into and toward the top of the kiln.

342,202—May 18, 1886. LEVEN S. GOODRICH. *Charcoal kiln.*

Claims a charcoal kiln provided with top and bottom inlets, in combination with branch supply-pipes connected with said top and bottom inlets and leading to the source of supply of hot gas, and provided with suitable dampers, whereby said gas may be admitted to the kiln either at the top or bottom, or both.

352,931—November 23, 1886. HENRY M. PIERCE. *Kiln for the manufacture of charcoal.*

Claims, as an improvement in the construction of movable or forest meilers, a rigid removable base section or breastwork having air ports and gas vents, and a soil or similar cap section.

360,238—March 29, 1887. JAMES E. McNAUGHTON. *Charcoal kiln.*

Claims a charcoal kiln consisting of vertical sides and an arched roof formed of sheet-metal plates secured together, rows of supporting pins secured to the ends of said roof and side plates, end plates of the kiln removably sustained by said pins, and upright frames connected by angle irons and eyebolts to the kiln walls.

399,255—March 12, 1889. JOHN FRIEDRICH. *Condenser for charcoal kilns.*

Claims the combination, with a kiln and an outer casing surrounding its lower portion, of division plates dividing the chamber between the kiln wall and casing into several communicating compartments, water pipes transversing said compartments, and connections between the interior of the kiln and the chamber between the kiln wall and casing.

399,634—March 12, 1889. MICHAEL SANDFORD. *Coke oven.*

Claims a coke oven constructed of equal-sized large blocks, having a laterally arched top and a common feed and discharge opening in the middle of said top and a door in its front, in combination with a heavy stone wall, rectangular in shape, provided with a door registering with the above-mentioned door not leaning on the front of the oven, and with its sides rising flush with the sides of said oven, so that when a number of said ovens are arranged side by side the side edges of said walls will be in contact all the way to the tops, and will support the earth packed between the arched tops of adjacent ovens, for the purpose of laying a railway track thereon.

418,306—October 22, 1889. EDWARD WILKES RATHBUN. *Kiln for making charcoal.*

Claims in a kiln for making charcoal, in which the gases are conveyed from the kiln to a condenser and then returned to the combustion chamber of the kiln, the combination of walls provided with flues beginning near the bottom of the kiln and terminating near the top thereof, a chamber for receiving the gases from said flues and having a pipe leading to the condenser, and a perforated combustion chamber, having a passage, and a pipe to convey gas from the condenser to the combustion chamber.

547,271—October 1, 1895. ERIK JOHAN LJUNGBERG. *Continuous charcoal kiln.*

Claims the combination of the kiln compartments, passages from one compartment to the adjoining compartment, a channel leading from each such passage to the chimney or other outlet, a furnace located in each passage to ignite the gases passing from one compartment to the adjoining compartment, and a double water-seal located at the connection of the said channel with the said passage, whereby each compartment may be connected either with the chimney or with the adjoining compartment.

607,931—July 12, 1898. JOSEPH BERRY. *Charcoal kiln.*

Claims a charcoal kiln consisting of a series of longitudinal sticks so laid as to provide lengthwise draft spaces, cross sticks laid thereon, a V-shaped space formed in the front end of the kiln by the proper stacking of the wood, a series of draft spaces formed around the edge of the kiln by the proper overlapping of a series of sticks to the right and left, a block from which these overlapping sticks start, and a block upon which the outer ends of the last of these overlapping sticks rest.

724,601—April 7, 1903. FRANK WOLF NEWBERGER. *Method of making charcoal and of conserving the vaporous distillates thereof.*

Claims the method of making charcoal and of conserving the vaporous distillates thereof, which consists in inclosing the logs to form the charcoal in an air-tight covering having means associated therewith to supply air as requisite to the pile, disposing between the logs, at the lower portion of the pile, downwardly inclined collectors which operate to catch the vaporous distillates as generated within the pile and convey them without the pile, and then condensing the distillates.

744,666—November 17, 1903. BERNHARD ZWILLINGER. *Carbonizing apparatus.*

In a carbonizing apparatus, the combination with a closed kiln, of a conduit leading from the kiln, a compressor, the inlet of which is connected with said conduit, a cooler located in the path of the gas between the kiln and the compressor, a vessel connected with the outlet of the compressor and adapted to hold water to partially deoxygenize any air that may be fed by the compressor, and to charge it with aqueous vapor, a heater connected with the outlet of said vessel, and a connection from the outlet of said heater to the inlet of the kiln so that a mixture of gases and air partially deoxygenized and charged with aqueous vapor will be forced into the kiln at the beginning of the operation.

748,457—December 29, 1903. HENRIK CONSTANTIN AMINOFF. *Apparatus for continual charring and dry distillation of organic substances.*

Claims in a charring and distilling apparatus the combination of an extended, inclined chamber, means for successively transporting the substance to be charred from the lower end of the chamber to its top end, a passage leading gases generated in the chamber from its lower end to the top end, and condensers, a fan and a heating device mounted in the said passage between the said lower end and the top end.

749,091—January 5, 1904. FREDERICK M. PERKINS. *Wood carbonizer.*

Claims, in a wood carbonizer, a carbonizing chamber to receive the wood to be carbonized, a furnace within the walls of the carbonizing chamber and within which heat is generated to carbonize the wood in said chamber, a flue from said furnace having branch flues communicating with the carbonizing chamber, said flue and branch flues also located within the walls of said chamber, and an exhaust flue from the carbonizing chamber.

COKE.

SUBCLASS 4.—COKE OVENS.

128,151—June 18, 1872. THOMAS G. KENNY. *Improvement in coke ovens.*

This invention relates to an improved portable coke oven, particularly applicable to use in connection with iron or other furnaces, whereby coal may be made into coke for smelting purposes at or near the blast furnace, so that the oven may be brought to the furnace at the time required and the coke discharged directly from the oven into the furnace while in a hot state, instead of being made at a distance and transported by cars or other means to the furnace in a cold state. By this means great saving, not only in fuel consumed but also of waste in transporting the coke from place to place, is obtained, and the coke is supplied to the furnace free from hydrogen.

214,056—April 8, 1878. LEON BEMELMANS. *Improvement in coke ovens.*

The invention consists in a coke oven having its top open throughout its length, and having an inclined bottom with a door at the lower end for discharging its contents from gravity, and a perforated false bottom and subjacent flue for carrying off the gases, and also in the combination of valves and doors for controlling and operating the oven.

232,389—September 21, 1880. EDWARD BURNS. *Coke oven.*

Claims in a coking oven, the combination of a ring-shaped smoke flue, extending horizontally around the oven, and at the rear side connected with its interior by a flame aperture and two air-supply flues, each having its inlet at the front wall and extending around the oven below the smoke flue, and at the rear having a connection with the ring-shaped smoke flue, but upon opposite sides of the flame aperture.

235,303—December 14, 1880. CASSIUS C. MARKLE AND ROLAND H. SMITH. *Coke oven.*

This invention relates to an improved construction of apparatus for the making of coke from soft or bituminous coals, wherein the carbonaceous gases from the ovens are carried directly to and through a series of condensers or washers, thence to a holder, and thence through pipes or passages in the inclosing walls of the oven or ovens for the reheating of the same, and are finally discharged in jets into the charge inclosed in the oven.

236,933—January 25, 1881. ARTHUR M. CHAMBERS. *Coke oven.*

The object of this invention is to furnish a device by which air is admitted to the interior of the oven above the burning coal, and directed to the flue leading to the chimney, so that the combustion of gas from the coal can be exactly regulated as desired, and the state of the interior of the oven can be watched at any time by an attendant, or its temperature tested by a pyrometer.

253,182—February 7, 1882. JOSEPH H. CAMPBELL. *Apparatus for extinguishing fires in coke ovens.*

This invention consists in the combination of a furnace, steam-jet pipe, water pipe, trap, and coke oven, arranged and operating with relation to each other so that the carbonic acid gas generated in the furnace is drawn therefrom through the medium of the steam jet and pipes and cooled and forced into the coke oven and into and among the burning coke, thereby extinguishing the fire and adding carbon to the coke.

258,489—May 23, 1882. WILLIAM B. SMITH. *Coke oven.*

The object of this invention is to provide simple and effective means for desulphurizing the coke, whereby the latter is better adapted for use in metallurgical furnaces and the iron or product obtained from the same is of a superior quality. To these ends the invention consists in a coke oven of any desired form or construction, which is traversed by a system of horizontal tubes that serve for the circulation of water and air through the same. The products of combustion in the oven will tend to generate a sufficient amount of steam in the tubes, which escapes through openings in the upper side of said tubes, and is readily decomposed in the oven, furnishing hydrogen and oxygen, that combine with the sulphur in the coal and carry it off.

276,002—April 17, 1883. BRODIE COCHRANE. *Coke oven.*

This invention has for its object to so construct the coke ovens as to utilize to the utmost the otherwise waste heat radiated from them for heating the air supplied to the interior of the oven, and at the same time to protect them from the loss and irregularity of heat which occur at the upper part as ordinarily constructed, when the roofs or domes, being exposed to the open air, are liable to great and sudden changes of temperature owing to winds, rain, snow, and atmospheric influences. These improvements effect not only an increased yield of coke, but also a considerable saving in the time necessary for coking and cover in Claim 1 a coke oven having over its ordinary dome a second dome with walls forming a series of communicating air flues, with an air inlet to the flues at one point and an air exit into the interior of the oven at another point.

287,433—October 30, 1883. HAYDEN H. HALL. *Gas and coke kiln.*

The invention consists in a kiln open at top, for charging and lighting, and having a removable cover, and also a blast and exhaust pipe or flue traversing it at the line of the base, floor, or grate of the charge-receiving chamber, another chamber being provided below the charging chamber, to receive the coke of each charge by the fall of the sectional floor or grate at the sides of the blast pipe, and further in special constructions of the blast or exhaust pipe in pyramidal cross-sectional form, and with higher and lower rows of exhaust apertures controlled by independently working dampers, and protected by overhanging plates or hoods from the drip of the residual tar from the coal. The exhaust pipe being suitably valved at the gas-discharge end, and fitted with a movable head at the opposite end, having telescopic connection with the valved outlet of the blowing engine or steam blast, for a controllable blast supply and for a means of cleaning the blast pipe, which communicates with suitable gas receivers for storing the gases or conveying them for use, and further, in the arrangement within the walls of the charge-receiving chamber fitted with a removable cover, and for charging and firing the charge from the top of the kiln, of pipes fitted with nozzles for ejecting superheated steam into the charged coal during the coal gas generating process, for increasing the downward draft and producing hydrogen gases, to mingle with the coal gases for intensifying the useful heating effect of the gaseous product.

289,887—December 11, 1883. JOSEPH BUTLER. *Coke oven.*

The invention consists in the combination, with an oven and its main discharge flue or stack, of draft passages arranged in the sides of the oven and adapted to admit air to the interior of the oven, and escape passages for conveying the products of combustion to discharge flues arranged independently of the main flue, and special features of construction and combinations of parts.

308,514—November 25, 1884. THOMAS NICHOLSON. *Apparatus for coking and collecting the resulting gases and their products.*

Claims a coking oven and pipe leading therefrom, combined with main and branch pipe and main provided, respectively, with valves and separate condensers, whereby early products or illuminating gas may be separated from the later product or heating gas and separately treated, as set forth.

420,897—February 4, 1890. WILLIAM W. ANDERSON. *Coke oven.*

Claims a coke oven having in combination a bed provided with a retaining ring and a removable dome or hood resting upon the bed outside of the retaining ring.

427,210—May 6, 1890. COLIN CAMPBELL WYLLIE. *Apparatus for utilizing waste gases from coke ovens.*

Claims the combination, with a furnace adapted to produce combustible gases, of a gas main or conduit leading therefrom, and a pneumatic pump whose cylinder and valves are indirectly connected with the gas conduit by means of branch pipes, whereby a body of dead gas is interposed between the main conduit and the cylinder.

459,064—September 8, 1891. ARTHUR MARSHALL CHAMBERS AND THOMAS SMITH. *Coke oven.*

Claims a coke oven provided at the top on one side with an outlet flue, an air-blast pipe discharging into the said oven below said outlet flue, but on the opposite side of said oven, a tubular outlet extending outward and downward from the lower part of said flue, a regulator in said flue above the outlet pipe, and a regulator in the latter pipe.

464,814—December 8, 1891. JOHN A. BECK. *Means for utilizing waste heat from coke ovens.*

Claims the combination, with a series of open topped ovens, of a fluid-containing vessel above the same and draft stacks or vents extending from said ovens through said vessel, each of said stacks or vents having a flaring lower end arranged at the inner end of a plurality of adjacent ovens and communicating with and carrying the waste heat from said plurality thereof.

469,866—March 1, 1892. THOMAS R. OSBOURN. *Coke oven.*

Claims in a coke oven, a structure forming a pit and a beehive oven situated above the same, and embodying in its masonry vertical lift channels, bores or tunnels exterior to the oven and extending from the top of the structure to the pit and terminating at their lower ends immediately over a movable floor, and lifts situated within said channels.

470,506—March 8, 1892. JOHANNES REITER. *Coke oven.*

The ordinary beehive ovens employed in the production of coke produce the best sort of coke, known as "patent coke," but have the drawback that they only produce a small output in consequence of the considerable burning away of the coal. This waste results from the inlet of air consequent on these ovens not being hermetically closed during working. In them the process of driving off the gases proceeds from top to bottom within the oven in consequence of air supplied from the outside, and coals having about twenty per cent of gas produce about sixty per

cent of coke. When such ovens are modified to admit of the recovery of the by-products contained in the oven gases and are altered so as to effect the hermetic closure necessary for the process of distillation, the gases generated in the ovens and freed in the condensation apparatus from the by-products are led under the floor of the oven for the purpose of heating it. By this modification it has been rendered possible to increase by sixteen to twenty per cent the output of coke produced in such ovens, which are thus transformed, as it were, into retorts, while obtaining a product of the same quality and commercial value as the coke produced in ovens of the old form; but, since these beehive ovens as altered for distillation working are heated from the floor only, the time required for the coking process is considerably greater than in ovens of other systems that are heated both from the floor and sides. The time required for coking in the aforesaid modified ovens is almost double that of the last mentioned ovens with the same charge and the same dimensions.

The present invention relates to the construction of an oven in which not only fine patent coke can be produced, but in which also the time required for coking is brought down to the reduced amount required for ovens of the more modern systems. This oven can also be employed for ordinary coking in lieu of the beehive ovens of the old form with small output. When it is so employed without any attempt being made to effect the recovery of by-products, the time required for coking is reduced by utilizing the raw and powerful gases generated within the oven. These gases are made to heat the oven from the sides simultaneously with the heating from the floor, thus effecting the driving off of the gases and also the complete shutting off of air from the interior of the oven, and in this manner the output is considerably increased. An oven of this kind is adapted to be employed not only in the production of coke from gassy fat coals, but also from a mixture of dust from dry coals or dust from flaming coals with coal tar or gas coals containing sufficient gas for coking. This oven is also adapted for producing coke from briquettes or blocks made from a mixture of coke waste and dust from dry coals or dust from flaming coals with a percentage of coal tar of six to eight per cent or fifty-eight per cent. If the content of gas of such a mixture be not sufficient alone to permanently maintain the heating of the sides and the floor of the oven, the oven can be connected with any existing battery of ovens and can take from it the requisite additional quantity of gas necessary for coking.

The drawing of the coke from an oven of this kind is effected by manual labor in a similar manner as in the ordinary beehive oven or in beehive ovens that have been transformed for the purpose of recovery of by-products, since a drawing machine is not effective in consequence of the round form of the said ovens. Since a drawing operation requires much time, the glowing coke must be cooled by quenching within the oven in order to prevent loss by the burning of the coke in consequence of the continued influx of air when the oven door is opened.

For two reasons the circular beehive form has been departed from in favor of an elliptical cross-section in which the major axis exceeds the minor axis in length by about one-fourth. One reason is that in a circular oven sufficient width of door for the drawing out can not be readily obtained without interference with the side flues, which occupy the parts of the periphery of the oven that are necessary for the oven door. Another reason for adopting the elliptical form is to obtain a large area of floor of a larger charging space. In an elliptical oven the door can be arranged on the side of the oven fronting the major axis at the point where the side flues are situated which are farthest apart and between which there is sufficient space for accommodating the door.

And the inventor claims a coke oven having a central chamber, a series of parallel flues beneath the floor thereof, arranged in two sets, a series of wall flues connecting with the parallel flues and opening into the space above the dome, division walls in said space, and a door opening to said central chamber above the line of the floor flues.

471,083—March 15, 1892. RICHARD DE SOLDENHOFF. *Coke oven.*

Claims the combination, with the ovens and the collecting flues communicating therewith, of gas flues formed in the side wall of said ovens and having communication with said collecting flues, a smoke flue, gas flues arranged under the ovens and communicating with the aforesaid gas flues and with said smoke flue, an air-inlet flue, and connected flues forming one continuous flue, having connection at one end with said air-inlet flue and at the other with the gas flues in the side walls of the ovens and being arranged under the gas flues.

471,692—March 29, 1892. HERMAN EKELUND. *Coking oven.*

This invention relates to improvements in furnaces for charring, roasting, baking, or coking wood, coal, or other material. This furnace consists of 3 principal chambers or compartments A, B, and C, of which chambers, A is for drying and heating, B for baking, charring, roasting, or coking, and C for extinguishing and cooling the roasted, charred, or coked materials received from chamber B. The chamber or compartment B is separated at its ends by partition walls from the adjoining compartments D and E. The compartments A and B are separated from one another partly by double-vaulted floors containing two channels and partly by sliding doors, by which the openings or passages between the compartments may be opened or closed. The compartments B and C are separated by vaulted floors, containing each only one channel, and by sliding doors in said floors. In the compartment C iron tanks or cisterns are placed. The furnace is covered by a vaulted roof or cover provided with the doors, a funnel or chimney, and an exhaust fan. The compartments A and B are to be filled with the materials to be operated upon. From a fireplace situated outside of the furnace the heat is conducted through an opening into the compartment D, through openings into the lower channels G, passes thence downward through holes in the bottoms of the said channels, into the compartment B, and effects there the charring, baking, roasting, or coking of the materials placed in said compartment B. The gases produced thereby pass through perforated or grate-shaped vaulted bottoms of the compartment B into the channels and from these through pipe into a tank or cistern, the circulation being maintained by means of a fan placed upon the latter. The gases proceed then through a pipe into the compartment E, the latter constituting a fireplace where the gas is ignited. Water and tar are condensed in a tank or cistern. From the compartment E the gases are conducted up into the channels and through openings in their roof into the compartment A.

472,115—April 5, 1892. WILLIAM T. GATES AND GEORGE H. SHARP. *Coke oven.*

The objects of this invention are to provide means for spreading or leveling the coal within the oven, for removing the coke from the oven, for separating the coke from the ashes, and for loading the coke into cars for shipment. And the inventors claim the combination, with an oven open at one end, of a plunger terminating at one end in a transverse head provided at its rear side with rearwardly disposed wings arranged parallel to each other and at opposite sides of the plunger, and means for reciprocating the plunger.

514,546—February 13, 1894. NILS KARL HERMAN EKELUND. *Coking furnace.*

Claims a coking furnace comprising a drying chamber extending across the upper part and divided into two parts by a horizontal partition wall, provided with doors, a central partition wall beneath the drying chamber having a conical apex, grated doors opening in each side of the conical apex and leading to coking chambers.

523,397—July 24, 1894. THOMAS CUMMINGS AND JOSEPH CUMMINGS. *Coke oven.*

Claims a coke oven consisting of a longitudinal chamber having arched openings at each end of the chamber, the openings formed the full width of the chamber, the jambs of the openings provided with metallic lazy bar supports, a chamber arch supported on the side walls, the chamber arch provided with tunnel heads, the tunnel heads being provided with dampers to partly cover the openings to desulphurize the coke.

523,602—July 24, 1894. ALBERT DICKINSON SHREWSBURY. *Coke oven.*

Claims in a coke oven, an intermediate chamber in the upper part of said oven, a division therein forming two parts, an air passage from the outside opening into one part of said chamber, an exhaust opening into the other part of said chamber, and a series of passages between said oven and both parts of the intermediate chamber.

538,898—May 7, 1895. FRANZ JOSEPH COLLIN. *Horizontal coke oven.*

Claims a coke oven provided with essentially horizontal chambers or ovens, channels arranged directly above the said chambers and communicating therewith, longitudinal passages extending between the said channels and communicating therewith, said passages being divided into two parts at approximately the center of the oven, sinuous channels arranged in the side walls of the oven and connected to the said passages at the ends of the oven, essentially horizontal flues located below the said sinuous channels and communicating therewith at the central portion of the oven, and bottom channels connected to the said flues and of which each two communicate with each other so as to cause the gases from either of the ovens or chambers connected to the said channels to pass successively under each of the ovens through the said two bottom channels, one of each two bottom channels being connected with a smoke flue.

595,733—January 4, 1898. JEANNOT W. KENEVEL. *Apparatus for coking and desulphurizing bituminous coal.*

Claims an apparatus for coking and desulphurizing bituminous coal, comprising, in combination, a structure containing a retort, a mixing chamber below the retort, a gas chamber below the opening into said mixing chamber, a base flue connected by ducts with said mixing chamber, air passages connected by ducts with said base flue, flues, passages connecting the mixing chamber with said flues, and steam-supply pipes leading through the passages into said retort, a steam generator with which said steam pipes are connected, a stack into which said flues discharge, a hydraulic main, a sulphur flue, a sulphur-intercepting chamber into which said sulphur flue discharges, and a pipe having valve-controlled branches and leading, respectively, to said sulphur flue and hydraulic main.

660,480—October 23, 1900. EDWIN A. BABBAGE. *Coke oven.*

Claims a battery of ovens, comprising parallel walls, two rows of ovens arranged between the walls with the ovens of one row opposite the spaces between the ovens of the other row, said ovens having door openings leading through the aforesaid walls, smoke passages leading from the rear walls of the ovens at a point about opposite the door openings and in line with the top portions thereof and communicating with vertical passages or stacks located between adjacent ovens and in line with the openings formed in the crowns thereof, pillars at the sides of the horizontal portion of the passages and extending thereover and to a point above the crowns of the ovens, and rails supported upon said pillars, the spaces between the longitudinal walls and the ovens being filled with earth or the like.

680,790—August 20, 1901. WILLIAM JOHN KNOX. *Apparatus for the manufacture of coke.*

Claims the combination of a superheater, one or more coking chambers, an inlet or outlet to each chamber at its upper part, a fixing chamber connected with the outlet of the coking chamber or chambers, means for continuously circulating gas through the heating chamber and the coking chamber or chambers in contact with the coal and coke and through the fixing chamber, and means for withdrawing and utilizing a regulable amount of the gas.

680,791—August 20, 1901. WILLIAM JOHN KNOX. *Apparatus for manufacturing coke and gas.*

The general plan of the invention is to pass the hydrocarbon vapors generated in coke ovens through suitable stoves in which more or less of the heat carried by the vapors is conserved or stored, thence through cooling devices—such, for instance, as a steam generator—and thence into heating stoves, where the temperature is raised to the degree required for effectively acting upon the coal to reduce it to coke. These heated vapors are then passed into the coking ovens and usually across the top of the bed of coal or coke. This operation is continued until the stove which has been employed as the heat-absorbing stove has absorbed and stored a predetermined amount of sensible heat, whereupon the direction of circulation is reversed and this stove is utilized as the heating stove and the former heating stove as the heat-absorbing stove, and this operation of reversal is repeated continuously at suitable intervals as long as the temperature of the stoves is sufficiently high to conduct the coking operation. Additional stoves may be employed, so that any stove which has previously been used as described and its temperature reduced thereby may be cut out of the circuit and further heated by the consumption of fuel therein to restore its condition as a heating stove. And the inventor claims the combination of one or more coking ovens, means for passing a heated fluid carrier through the coking ovens, means for cooling the fluid carrier as it passes from the coking ovens and means for reheating a regulable amount of the fluid carrier for retransmission therethrough.

681,064—August 20, 1901. RICHARD DANIEL MARTIN. *Drawing machine for coke ovens.*

A drawing machine having a scraper, comprising a scraper guideway, a scraper beam mounted to slide thereon, a scraper blade hung on said beam, a horizontally arranged shaft on which said guideway is fulcrumed to swing up and down, means for actuating the scraper beam from said shaft, a vertical shaft on which one end of said horizontal shaft is fulcrumed, whereby the said horizontal shaft and the guideway may be swung laterally, gearing between the said shafts, and a shaft arranged to drive the said vertical shaft and on which the latter is mounted to swing.

690,748—January 7, 1902. RICHARD D. MARTIN. *Coke oven.*

Claims adjoining coke ovens separated by an intervening wall having a V-shaped passage leading directly from one oven to the other through the outer part of the masonry, in combination with means for opening and closing said passage.

701,219—May 27, 1902. PAUL NAEF. *Apparatus for the manufacture of coke.*

The object of this invention is to provide an apparatus to produce coke or to coke coal in a single furnace in much larger quantities than has been done heretofore and on a scale commensurate with the requirements of a blast furnace and to utilize the by-products. Further to provide an apparatus to do this with a small waste of heat, so that the heat units required for the distillation only are consumed, the remaining heat units being retained in the coke and gas; to in-

crease the production of ammonia by the action of superheated steam on the coke in an incandescent state; to utilize the heat of the incandescent coke for producing steam and superheating the same; to make the coking of the coal and the cooling and loading of the coke wholly automatic; to manufacture fuel and illuminating gas, as well as tar, ammonia, and coke; to reduce the cost of plant investment and repairs per ton of coke, and to effect great economy in the cost of production and in the utilization of the by-products and also to construct the apparatus so as to utilize the nitrogenous components which are with ordinary coking processes left in the coke (and which represent usually more than fifty per cent of the nitrogen contents of the coal) for the production of ammonia, while providing an apparatus by means of which to produce a coke with a low percentage of ashes and to avoid the combustion of coke in the coking apparatus, the heat necessary for the coking being supplied from a separate heating apparatus. And the inventor claims a coking apparatus consisting of a shaft provided at its lower end with a coke outlet and having inlets for gaseous fluid, inlets for steam at a lower level than the gaseous-fluid inlet and inlets for water at a still lower level all of said inlets being above the coke outlet.

705,681—July 29, 1902. RUDOLF KUHN. *Process of making the interior of coke ovens or other kilns tight.*

Claims a process of making the interior of coke ovens and other kilns tight which consists in mixing fine ore-dust with fine-ground ashes or other dusty material and then blowing the mixture into the hot chamber, the walls or sides of which are intended to be tightened, the effect being that the dust will keep floating for a while and then settle by degrees in the pores and cracks and thereby make the walls perfectly tight.

707,914—August 26, 1902. WILLIAM T. GATES. *Coke oven.*

The invention consists in arranging the forty-eight hour or furnace-coke producing oven on a plane below that occupied by the seventy-two hour or foundry-coke producing oven and in directing the heat from the forty-eight hour oven into and beneath the floor of the seventy-two hour oven, and thence entirely around the lower portion of the side walls thereof. The improvements hereinafter described are equally adaptable to seventy-two hour ovens having either single or double walls, the result being affected in the former case by providing externally arranged flues around the lower portion of the oven to receive the heat from the forty-eight hour oven and in the latter case by providing an internally arranged flue between the walls of the lower portion of the oven.

711,500—October 21, 1902. JOHN M. HUNKER. *Coke oven.*

Claims a coke oven in the walls of which is arranged a series of blocks, said blocks formed with centrally arranged longitudinal and transverse openings, said transverse openings communicating with each other, thereby forming a continuous passage, and the longitudinal openings forming a series of direct communication between the exterior and the interior of the coke oven.

711,904—October 21, 1902. THADDEUS S. C. LOWE. *Apparatus for the manufacture of coke and the recovery of gases therefrom.*

Claims the combination of a plurality of coke ovens, passages connecting the ovens above the coke line, a superheater and a steam generator at each end of the ovens, passages forming communication between the superheaters and the ovens, and passages forming communication between the steam generators and the superheaters, means for admitting air to either end of the apparatus, and means for admitting water to the steam generators, exhaust passages in each steam generator, and means for carrying off the resultant gases.

718,008—January 6, 1903. THADDEUS S. C. LOWE. *Air heater and steam generator.*

Claims the combination, in an apparatus for making gas from coking coal, of a coke oven, a steam generator on each side thereof and communicating with the coke oven above the coking line, upper and lower sets of metal bars or ironwork in said generators, a valved air inlet communicating with each of the generators above the said upper set, a steam or water supply pipe communicating with each of the generators between the said upper and lower sets, a waste-gas outlet for each of said generators, and a gas outlet from each of said generators.

722,982—March 17, 1903. LOUIS J. HIRT. *Coking oven.*

This invention relates to a coking oven wherein the process of coking a plurality of grades or kinds of coal may be simultaneously carried on without interfering one with the other or wherein a single grade or kind of coal may be coked. For this purpose the coking oven is provided with a plurality of retorts or chambers which communicate at their upper ends with a gas-outlet passage or flue separated from the coking chambers, except as to the gas-outlet ports, by a wall of refractory material, which serves to prevent the gas in the passage from being influenced by the heat of the coking chambers to such extent as would destroy the light hydrocarbons. The gas-outlet passage or flue referred to may be designated the "main" outlet passage and has communicating with it a second gas-outlet flue or passage, which may be placed in communication with one or more of the coking chambers by means of one or more valves in the main outlet passage, so that a rich kind or grade of coal in one or more of the coking chambers and a poorer grade or kind in the other of said coking chambers may be coked simultaneously, and the richer gases may be carried off through the main flue or passage and utilized for illuminating or for other purposes and the poorer gases may be carried off through the second outlet passage and utilized for heating the ovens or coking chambers or for other purposes.

724,032—March 31, 1903. GEORGE FRANCIS MYERS. *Coke oven.*

The main characteristic feature of this invention consists in providing a U-shaped floor for the oven, while retaining the dome shape of the present bechive oven, preserving all the advantages of the bechive oven—such, for instance, as its good coking qualities—but dispensing with the small door in the front part thereof, providing in lieu of said door a door equal in width to the full width of the oven, thereby facilitating the discharging of the coke from the oven.

725,646—April 14, 1903. ROBERT S. MOSS. *Coking oven.*

Claims, in a coking oven, the combination with the coking chamber, of a series of air-discharging apertures or openings in the wall of the oven, each aperture or opening having a lateral inclination for projecting air into the coking chamber at an angle and giving a circulation thereto around and within the coking chamber, a bottom for the coking chamber, an air-supply chamber in the bottom, and a flooring or covering for the air-supply chamber having perforations or slits therein gradually increasing in width from the point of admission to the side farthest removed from the admission of air.

732,097—June 30, 1903. CASPAR W. METTLER, ADOLF METTLER, AND JACOB METTLER. *Coking kiln.*

Claims a kiln having two coking chambers with brick side walls, center wall and roof, and iron doors at both ends, tracks extending through the coking chambers, a furnace extending transversely below one end of the coking chambers, flues extending through the walls from the combustion chambers of the furnace and opening into the top and bottom of the coking chambers, dampers for controlling the openings from the flues into the chambers, flues extending longitudinally under the bottom of the coking chambers to a tank and a stack communicating with the tank.

733,872—July 14, 1903. GEORGE SHARPE RAMSAY. *Coke oven.*

Claims a coke oven having a charging opening at the top thereof, a door in the front of the oven for withdrawing the coke, a stack located in rear of the oven, a main flue located centrally below the floor of the oven with its front end piercing the front of the oven wall and its rear end in communication with the stack, a damper door for the front end of the flue, substantially radial flues at opposite sides of and in communication with the main flue and permitting the products of combustion to pass directly to the stack, other radial flues terminated short of the main flue, transverse flues connecting the radial flues and also in communication with the main flue, and independent upstanding flues upon the exterior of the oven wall with their upper ends piercing the oven wall for communication with the interior of the oven and their lower ends in communication with the flues beneath the floor at the points of intersection between the outermost transverse flues and those radial flues which terminate short of the main flue, the upstanding flues being located at opposite sides of the main flue and at the front and rear of the oven.

740,078—September 29, 1903. THEODOR VON BAUER. *Coke oven.*

Claims the combination of a battery of coke ovens, air channels located in the foundation of the same, intermediate channels located between the sole channels and the crown of the air channels, channels connecting the air channels with said intermediate channels, combustion flues in the partition walls between the ovens, gas-distributing and return-gas flues above said combustion flues and connected therewith, air-supply pipes terminating in openings at the upper parts of said combustion flues, and connected with the intermediate channels, and a sole channel connected with the lower ends of the combustion flues.

744,668—November 17, 1903. BERNHARD ZWILLINGER. *Apparatus for carbonizing.*

Claims in a carbonizing apparatus, the combination of a kiln, a heater for gases having two separate channels, channels located under the kiln, and connection from one of the channels of the heater to said channels under the kiln, a cut-off device located in said connection, a device located in said connection between the cut-off device and the kiln for connecting the channels under the kiln with the atmosphere at their supply end, or closing said channels to the atmosphere at said end, a draft device connected with the outer end of the channels under the kiln, means for conveying a gaseous mixture to the outer channel of the heater, and a connection through the outlet of said outer channel to the interior of the kiln.

745,290—November 24, 1903. PAUL NAEF. *Apparatus for the manufacture of coke.*

Claims the combination in a coking apparatus having two chambers, of hollow doors between said chambers, having a partition, and the hollow revoluble shafts to which the doors are secured having a partition, and a cooling ring formed in sections, and surrounding the doors, and with the shafts extended therethrough, means for circulating water from a water supply through the shafts, doors, and ring, comprising an induction pipe, having branches joined to one end of the shafts *so that the latter can be revolved, an induction pipe from said branch to the ring,* a discharge pipe connected to said water supply, and having branch pipes with rotary joints at the other end of the shafts, and a discharge pipe from the said *ring to the said discharge branch.*

760,372—May 17, 1904. JACOB B. BEAM. *Coke oven.*

Claims the combination of a series of ovens, a main flue running parallel with the ovens below the top level and communicating with the ovens by branch flues which enter the ovens above the coke level and close to the filling orifices of the ovens, valves in the branch flues controlling the passage of gases from the ovens to the main flue, a furnace close to the ovens and connected with the main flue by a branch flue and a valve in said branch flue for regulating the admission of gases to the furnace and which when closed causes the gases to back up into a recently charged oven.

761,521—May 31, 1904. JOSEPH SPEAR MAXWELL. *Coke oven.*

Claims the combination with a long series of coke ovens arranged in a single structure, of pairs of end ovens spaced from the structure, each oven being rectangular in cross area and having an arched top provided with a central vent, brace beams extended upward along the end walls of the pair of ovens, tie rods connecting opposite beams above the ovens, braces extended across the spaces between adjacent walls and connecting said walls, a packing of dirt or the like supported on the ovens, and car tracks extended along over all of the ovens at one side of the vents.

763,368—June 28, 1904. MICHAEL R. CONLEY. *Electric coke oven.*

Claims a coke oven of nonconducting material open at the top and provided with swinging doors at the bottom which open the full bigness of the oven, and electric resistance-plates held in the inner wall of the oven to heat it, the entire height of the oven being left clear and unobstructed.

769,240—September 6, 1904. JASPER H. BOWLING. *Coke oven.*

Claims in a battery of beehive coke ovens the combination with an oven of a substantially straight, horizontal main flue located adjacent to one side of and below the floor of said oven and communicating at one end with the exterior, a similar main flue located at the opposite side of said oven, a chimney with which said second flue communicates, a plurality of substantially straight and parallel cross flues extending from the first mentioned flue to the second, and a flue leading from the interior of an adjacent oven into said first mentioned main flue, said cross flues being constructed of tile of rectangular cross section and said main flues having their upper walls composed of plate tiles resting by one edge upon the tiles which form said cross flues.

773,809—November 1, 1904. GEORGE S. RAMSAY. *Coke oven.*

Claims a coke oven having a stack, and provided with a central main bottom flue communicating at one end with the stack, front and rear upstanding flues communicating at their upper ends with the interior of the oven, and the independent front and rear bottom flues connecting the upstanding flues with the main bottom flue, the rear bottom flues being shorter than the front bottom flues, and the walls separating and forming the front and rear bottom flues being continuations of the outer walls of the oven to provide continuous supports for the floor of the same.

786,694—April 4, 1905. JAMES M. SULLIVAN. *Coking oven.*

Claims in an apparatus for coking coal, the combination with a plurality of ovens arranged in parallel series, of party walls separating adjoining ovens through which passages extend, a flue extending between the series of ovens having passages communicating with the individual ovens in each series, dampers controlling said passages in the walls and in the flue whereby alternate ovens in each series may communicate with said flue through the adjoining ovens, and means for forcing air through said flue thereby promoting the draft through the ovens.

793,668—July 4, 1905. DANIEL F. LEPLEY. *Coke-oven attachment.*

Claims in apparatus for the utilization of waste gases from coke ovens a stationary coke oven having a charging hole at the top of the oven, and through which a charge of coal may be deposited in said oven, a gas conduit, a valveless duct leading from the conduit toward the oven and opening at the top of the oven, and a pivotally mounted flue member movable to establish communication between the hole and duct, and for closing communication between the duct and the outer air.

Subclass 5. Coke Ovens—Chargers and Dischargers.

61,144—January 15, 1867. SEALY JAMES BEST AND JAMES JOHN HOLDEN. *Improved apparatus for charging and drawing gas retorts, and other like purposes.*

Covers a system of scoops and scrapers mounted on a traveling platform.

75,308—March 10, 1868. JAMES F. SNEDIKER AND WILLIAM F. BAILEY. *Improved apparatus for charging gas retorts.*

Claims a truck and its swivel bearings in combination with a series of scoops, the handles of which rest on and slide in the said bearings, a sliding bottom, in combination with a scoop, a scoop, consisting of adjustable sidepieces, and bottom pieces constructed, arranged, and connected to a handle, and wheels in combination with a scoop.

94,045—August 24, 1869. N. O. J. TISDALE. *Improved machine for charging gas retorts.*

Claims a guide-way, a charger, when provided with reversible bottom or apron, and the combination of the guide-way and charger.

109,940—December 6, 1870. THOMAS PRICE. *Improvement in coke furnaces.*

Claims a cradle placed in a coke furnace to serve as a grate and conveyor for the coal, a coke furnace provided with curved smoke channels, and a furnace arranged in line with the coke furnace to receive the cradle containing the coke.

114,682—May 9, 1871. JAMES JOHN HOLDEN. *Improvement in apparatus for charging and discharging gas retorts.*

This apparatus for charging and discharging gas retorts comprises a traveling frame, carrying a set of scoops, feeders, or charging tools or instruments on one side, and a set of rakers, rakes, clearers, or drawing or discharging tools or instruments on the other side, and having a to and fro motion on a traversing frame or carriage. The set of scoops or charging instruments and the set of rakes or discharging tools or instruments are mounted and arranged, each set respectively, on an upright spindle, or on a framing on the carrier, so that each set is capable of being swung, turned, or moved partially around, in order that such set may be brought either lengthwise of or at an angle to the general body of the apparatus, as required.

120,151—October 24, 1871. DARIUS DAVISON. *Improvement in the manufacture of coal gas.*

Claims the process of manufacturing coal gas by dividing the usual whole charge into two equal parts, or thereabout, and depositing each fresh supply of a divided charge in rear of the retort and successively distributing a series of such partial whole charges within the retort at intervals in a progressive manner from the rear toward the mouth of the retort.

127,144—May 28, 1872. LA FAYETTE BLAIR. *Improvement in gas retorts and apparatus for charging.*

The first part of the invention relates to the construction of the gas retort, which is built up in masonry in the usual manner. Both ends of the retort extend outside of the walls, the front end for the convenience of filling the coal magazine and the rear end for discharging the coke. The magazine is attached on the top and near the front end of the retort. The contents of the magazine are kept in their place by the slides which pass into the conductor of the magazine. The second part of this invention relates to the combination of the coal distributer and the coke scraper.

130,388—August 13, 1872. ROBERT PORTER AND THOMAS LANE. *Improvement in gas apparatus.*

Claims a retort in combination with a central rotating screw, having a sloping or inclined thread adapted to cause the coal to pass through the retort in close contact with the heated surface of the retort.

131,504—September 24, 1872. THOMAS F. ROWLAND. *Improvement in machines for charging gas retorts.*

Claims a scoop, with suitable supporting means, and having a removable bottom, and valves, combined and arranged for joint operation, and a removable bottom corrugated longitudinally, in combination with correspondingly formed valves and curved sides adapted to match in a D-retort, and reciprocate separately therein.

134,055—December 17, 1872. ALONZO F. HAVENS. *Improvement in apparatus for charging gas retorts.*

Claims a scoop for charging gas retorts made in two or more segments, and each segment hung at the ends upon separate center studs, in combination with mechanism, for giving to the segments a swinging movement to discharge the contents into the retort.

134,056—December 17, 1872. ALONZO F. HAVENS. *Improvement in apparatus for charging gas retorts.*

Claims a chute, in combination with a coal hopper and mechanism for sliding in and withdrawing the chute so as to receive its supply of coal while being moved into the retort, and scrapers or detainers combined with the chute for causing the delivery of the coal into the retort.

134,389—December 31, 1872. THOMAS F. ROWLAND. *Improvement in apparatus for filling gas retort chargers. (Reissue No. 7,681, April 24, 1877.)*

Claims a cylindrical measure or meter, consisting of a revolving barrel or cylinder, having an opening for the reception and discharge of coal and arranged to be revolved completely around its axis, in combination with a hopper, and one or more guides for measuring and transferring coal into the retort chargers.

137,485—April 1, 1873. THOMAS F. ROWLAND. *Improvement in apparatus for charging gas retorts.*

This invention provides buckets adapted to receive the charges of coal laterally at the proper point, and carry them by means of a suspended railway along the fronts of the retorts, dropping the coal automatically at the required points by opening the bottoms of the several buckets.

137,486—April 1, 1873. THOMAS F. ROWLAND. *Improvement in apparatus for raking gas retorts. (Reissue No. 7,592, April 3, 1877.)*

Claims a rake and rake carriage, combined with mechanism which, upon the forward motion of the carriage, automatically raises the rake, so that it passes into the retort free of the coke, and which, upon the backward motion of the carriage, drops the rake into the coke.

137,487—April 1, 1873. THOMAS F. ROWLAND. *Improvement in gas retort chargers.*

The apparatus described in the inventor's previous application for patent for charging gas retorts has a revolving meter with only one aperture. A certain period is required for any meter to fill properly with coal, and, again, a certain period for it to empty. The present improved apparatus provides a larger revolving meter with an increased number of apertures and chambers, so that one may be filling while another is emptying. It allows for the convenient changing of the capacities of the chambers by the insertion and removal of pieces. This allows the meter to be charged as the retorts become gradually filled or encumbered with gas carbon. It provides automatic mechanism for changing the position of the deflectors or valves that determine into which of the retorts the charge shall be placed. It provides steel knives for better cutting off the coal when an aperture in the meter passes out of contact with the supply passage. It also provides checks for retarding the motion of the coal in descending to reach the lowermost of the retorts, which tends to equalize the velocity of the coal in passing into all the several retorts.

140,624—July 8, 1873. ALONZO F. HAVENS. *Improvement in apparatus for charging gas retorts.*

Charging scoops for gas retorts have been made for delivering the contents into the retort by drawing aside a divided segmental bottom. This present invention is for accomplishing the same object, but by different mechanism, consisting of a bottom to the scoop made of two leaves hinged together in the middle, lengthwise of the scoop, and attached to arms that are employed for lifting up the central portion of the hinged bottom, so as to draw in the edges and allow the coal to be delivered off the leaves in their inclined positions toward the angles of the retort, so as to be more easily and evenly spread upon the bottom of the retort than in those cases where the coal is delivered in the center of the retort.

145,039—September 23, 1873. JOHN SOMERVILLE AND JOHN ROBINSON. *Improvement in apparatus for charging gas retorts.*

Claims the combination of a cradle, having detents or stops arranged in pairs on rocking spindles, with vertical rakes and operating levers.

144,526—November 11, 1873. WILLIAM FOULIS. *Improvement in apparatus for charging and drawing gas retorts.*

Claims an apparatus for charging or drawing retorts, in which the scoop or rake is combined with and operated by the piston rod of a water or other fluid engine.

148,841—March 24, 1874. PETER MUNZINGER. *Improvement in gas retort chargers.*

The invention consists, first, of a revolving scoop carrier in connection with a wagon or other suitable carrying device; second, of a revolving scoop carrier in connection with suspension or scoop carrying devices; third, of a revolving scoop-carrier in connection with geared wheels for working the same; fourth, of a revolving scoop carrier in connection with a ratchet wheel and a detent for holding the said scoop carrier in any required position.

149,836—April 21, 1874. JOSEPH H. CONNELLY. *Improvement in apparatus for drawing coke from ovens.*

This invention consists in a long-handled hook and fork, forming a pair of tongs mounted on a carriage, with which the coke is grasped and removed from the oven; or a long-handled hook mounted in a similar carriage.

160,490—March 2, 1875. JOHN WEST. *Improvement in chargers for gas retorts.*

This invention consists, mainly, in the peculiar construction of a charger or carriage adapted to convey coal into the retort, and distribute the same in an even layer throughout its entire length. It consists, further, in the combination of the charger with the retort, and a hopper for supplying it with coal without rendering necessary the opening of the retort.

165,667—July 20, 1875. WILLIAM FOULIS. *Improvement in apparatus for charging retorts.*

Claims the combination of a scoop, capable of both longitudinal and rotary movements, a hauling chain connected at both ends to and lapped in opposite directions round the scoop, and appliances for imparting motion to the chain in either direction.

168,968—October 19, 1875. PROVANCE M. BUTTERMORE. *Improvement in scrapers for coke ovens.*

Claims a scraper for coke ovens having a cast iron blade that tapers, in cross section, from the heel to the point, and that has a flange, on the rear side of the blade, that tapers from the center to the edges, in combination with a wrought iron rod roughened or made crooked on its end.

173,844—February 8, 1876. JOEL F. RICE. *Improvement in apparatus for charging retorts.*

In order to prevent loss of gas, and also cracking of retorts by sudden change of temperature, chargers holding a large quantity of coal, and provided with devices for operating them quickly, have been devised, and to some extent adopted in practice. This invention is an improvement in this class of apparatus; and consists, chiefly, in the arrangement of a plug or stop device and means for locking the same, or holding it stationary, in the frame that supports the tubular reciprocating charger.

177,326—May 16, 1876. WILLIAM FOULIS. *Improvement in machines for charging retorts.*

Claims a combination of parts constituting the mechanism for traversing the scoop and by which the charging apparatus is raised and lowered.

177,327—May 16, 1876. WILLIAM FOULIS. *Improvement in apparatus for drawing retorts.*

Claims the mechanism whereby a hydraulic cylinder may be utilized in traversing the machine continuously in one direction and the rake is operated.

182,132—September 12, 1876. JOEL F. RICE. *Improvement in apparatus for removing coke from retorts.*

This invention consists of a sliding scoop placed on a swiveled support that is carried by a truck, the scoop being forced into the retort under the coke by a winch and withdrawn by the same means.

192,288—June 19, 1877. THOMAS F. ROWLAND. *Improvement in retort charging and discharging apparatus.*

Claims the combination of a meter, a coal charging apparatus having a removable bottom, and a coal discharging apparatus, and an engine carried upon the same frame and adapted to be brought opposite the retort to be discharged.

192,289—June 19, 1877. THOMAS F. ROWLAND. *Improvement in gas retort chargers.*

Claims the combination of a scoop, having a removable bottom with a supporting traveling frame, which carries said scoop, and is itself supported upon two sets of runners or rollers, one set of which travels upon the upper surface of a rail, while the other set travels upon the under surface of a rail.

192,290—June 19, 1877. THOMAS F. ROWLAND. *Improvement in gas raking apparatus.*

Claims a rake and rake handle combined with mechanism, whereby the downward position of the rake upon the bottom of the retort is regulated or altered at any point of its travel, while the rake and rake supporting mechanism advance and retire in the same line, as distinguished from a rake which is laterally adjustable by the lateral movement of its entire supporting mechanism.

192,291—June 19, 1877. THOMAS F. ROWLAND. *Improvement in revolving coal meters.*

Claims the combination of a coal meter and an adjustable chute with mechanism whereby the chute is automatically lowered into the scoop beneath during the passage of the coal and is automatically raised after its discharge, whereby the scoop is enabled to advance into the retort free of the chute.

194,998—September 11, 1877. CHARLES F. DIETERICH. *Improvement in machinery for charging gas retorts.*

Claims a coal transporting car having one or more series of invertible troughs placed one above the other, each trough having capacity for a charge for a single retort, and being constructed to empty its contents into a retort charger when placed thereunder.

199,316—January 15, 1878. ABBOTT Q. ROSS. *Improvement in gas retort chargers.*

This invention consists, first, of a retort charging apparatus embracing, in its construction, a carriage or frame, a bar projecting therefrom and supported thereby, and a divided scoop, pivoted to said bar, and arranged to open at the bottom by the swinging of its parts outward, the whole being designed to carry coal into the retort without depending on the latter for the support of any part of the apparatus, and to permit the withdrawal of the scoop without obstruction from the coal deposited; second, of a certain combination of parts, making up an automatically operating device for opening and closing the scoop at the ends of its longitudinal movement; third, in attaching a swinging plate to the forward end of the bar to which the two parts of the scoop are pivoted, which plate is used to discharge the fuel from open-backed or "through" retorts, and may be operated to rake the fuel from retorts open at the front only.

200,888—March 5, 1878. THOMAS H. BIRCH. *Improvement in charging scoops for gas retorts.*

Claims the series of buckets, pivoted transversely within an open scoop-frame, and having geared or other suitable connection with one or more slide bars or racks.

212,569—February 25, 1879. ABBOTT Q. ROSS. *Improvement in gas retort discharging apparatus.*

Claims an automatic discharging rake constructed to enter a retort, and provided with a longitudinally acting spring, situated between the rake and rake carriage, for the purpose of preventing injury to the rake or the retorts when the rake is forced into the retort and of allowing the rake to yield and slide toward the carriage.

212,570—February 25, 1879. ABBOTT Q. ROSS. *Improvement in charging gas retorts.*

Claims the mode of charging gas retorts, consisting essentially in first separating from the mass of coal a full charge for the retort and then blowing said charge in quickly at one operation by the action of dry steam or compressed air.

212,571—February 25, 1879. ABBOTT Q. ROSS. *Improvement in gas retort dischargers.*

Claims in a retort discharger, the combination of a long longitudinally movable blast pipe with a laterally movable discharge end to enter the retort to a point behind the materials to be discharged therefrom, and deliver the blast directly into said retort, with a steam or compressed air reservoir, a connecting pipe leading from such reservoir, and a controlling cock.

212,572—February 25, 1879. ABBOTT Q. ROSS. *Improvement in gas retort chargers.*

The object of this invention is to provide, for the use of small gas manufactories, a simple and convenient hand truck charger, whereby a full charge of coal can be wheeled to the retort, brought to the proper position, and discharged into the retort by a blast of steam or compressed air; and the invention consists, first, in a combined charger and two-wheel truck provided with blast jets and a connection for a flexible telescopic or jointed pipe for introducing the steam or compressed air; and, secondly, in an agitator, operated in part or in whole by the compressed air or steam, for the purpose of feeding the coal down properly in the charger.

212,573—February 25, 1879. ABBOTT Q. ROSS. *Improvement in gas retort chargers.*

Claims the combined charger, conduit, and blast pipe, in combination with mechanism for raising and lowering them together, whereby the several charges are adjustable to the height of their respective retorts, and delivered into the same without the necessity of recharging the apparatus during the operation.

217,272—July 8, 1879. CHARLES F. DIETERICH. *Improvement in apparatus for removing coke from gas retorts.*

This invention relates to an apparatus for removing coke from gas retorts, specially designed for use in connection with an apparatus for charging gas retorts patented to me on the 11th day of September, 1877.

This invention consists, first, in mounting a series of extensible rakes in a frame having a central screw pivot, which works in a nut or bearing forming part of a wheeled car, whereby when the car bearing the rakes is wheeled to the front of the retorts upon a track suitably situated the rakes may be adjusted by means of the screw pivot to the requisite height, and by other suitable means projected into and withdrawn from the retorts, for the purpose of removing the coke therefrom. The invention consists, secondly, in means whereby the prongs of the rakes may be swung or raised, for the purpose of facilitating their passage to the farther ends of the retorts and lowered, so as to catch the coke when said rakes are to be withdrawn, and also in the specific means employed for effecting the projection and retraction of the rakes. Lastly, the invention consists in means whereby the rakes may be adjusted in height independently of the supporting framework thereof.

218,089—August 19, 1879. FREDERICK A. SABBATON. *Improvement in devices for feeding gas retort furnaces with ignited coke from the retorts.*

This invention consists of a device having combined therein a spout fitting the ordinary feed door, through which solid fuel is introduced into the furnace, a conduit which, when the spout is adjusted to the feed door, will receive hot coke drawn from a retort in the furnace and conduct the coke into the spout, and a passage arranged opposite to the spout, and through which the workmen can use a stoking bar to push the coke from the spout through the feed door and into the furnace, and in the combination with the device composed of the spout, conduit, and stoking passage of a wheeled truck, whereby the whole is rendered conveniently portable and readily adjustable to the furnace.

222,562—December 9, 1879. ABBOTT Q. ROSS. *Improvement in gas retort chargers.*

Claims in a gas retort charger, a main car or platform, movable back and forth in front of the retorts, a secondary frame or support for the charging hopper, movable in or out toward and from the retorts, a steam-charging hopper or vessel, and means for raising and lowering the same vertically, and a steam receiver and boiler, located on the main car or platform, and connected with the charging vessel by a flexible or jointed pipe.

222,563—December 9, 1879. ABBOTT Q. ROSS. *Improvement in machinery for discharging gas retorts.*

Claims in combination with a reciprocating rake or series of rakes, an automatically adjustable counter balance, in combination with and actuated by the piston rod and connecting mechanism.

222,564—December 9, 1879. ABBOTT Q. ROSS. *Improvement in gas retort discharging apparatus.*

Claims in a gas retort discharger, the combination, with a reciprocating traveler, of two rakes or series of rakes located on opposite sides of the traveler, devices for connecting either of said rakes or series of rakes to the traveler when desired, and devices for connecting either of said rakes or series of rakes to a stationary part of the machine when desired, whereby either of the rakes or series of rakes may be thrown into operation while the rest remain idle and are cooling.

222,565—December 9, 1879. ABBOTT Q. ROSS. *Improvement in discharging apparatus for gas retorts.*

Claims in a gas retort discharger, the combination, with a rake or rakes hinged to a reciprocating traveler, of an adjustable support for said rake or rakes, by which their elevation and depression may be controlled at any part of their stroke, or when the traveler is at rest, at the will of the operator, and with a counter balance for assisting in said elevation and depression.

249,694—November 15, 1881. RICHARD THOMAS. *Coke furnace and apparatus connected therewith.*

Claims the plant for manufacture of coke consisting of elevated furnaces or retorts, provided with doors at both ends, tracks, elevating apparatus, engine, and endless traveling rope.

276,504—April 24, 1883. RICHARD THOMAS. *Coke furnace and apparatus connected therewith.*

This is a device for withdrawal of coke from ovens or furnaces and loading it into cars.

300,468—June 17, 1884. JONATHAN GREEN. *Coke oven.*

Claims in coke oven, the cradle comprising the gas pipe frame, having series of apertures and prongs upon its upper surface, said prongs being adapted to support and retain the coke upon the cradle while being drawn.

314,510—March 24, 1885. GEORGE W. BIERER. *Apparatus for removing coke from ovens.*

Claims in a machine for drawing coke from ovens or kilns, the combination of a frame with a block sliding thereon, and picks or forks provided with means for giving lateral and horizontal motion to the forks or picks, and lever and treadle for raising the ends of the picks or forks as they enter the oven or kiln.

315,595—April 14, 1885. EDMUND J. BOWEN. *Coke oven.*

Claims a coke oven having an inlet opening at one end and an outlet at its opposite end and having its floor inclined downward toward its discharge or outlet end and provided on such floor with a longitudinal series of rails arranged side by side and a slight distance apart.

322,128—July 14, 1885. THOMAS F. ROWLAND. *Machinery for charging retorts.*

Claims in combination, in a retort charging machine, a scoop provided with a sliding bottom, a hydraulic apparatus for projecting and withdrawing the scoop, consisting of a cylinder attached to the scoop and moving on a fixed piston, and a like hydraulic apparatus for projecting and withdrawing the bottom of the scoop.

362,130—May 3, 1887. FREDERIC C. WEIR. *Machine for pulling coke from ovens.*

This invention comprises driving devices operated by an engine, preferably mounted upon a car, which can be run up in front of the oven, and a windlass operating a reciprocating arm carrying the pulling claws, with suitable mechanism for stopping, starting, tilting, and operating the reciprocating claw-arm.

365,489—June 28, 1887. JULIUS QUAGLIO. *Apparatus for compressing coal and introducing the same into coke ovens.*

Claims the combination, with a carriage, of a chest for receiving and pressing coal, a sliding bottom plate in the chest, a coke case on the carriage, a hinged bottom on the coke case, an engine on the carriage, and a windlass opposite one end of the chest for receiving the coal, which windlass is operated from the engine.

376,531—January 17, 1888. AUGUST LENTZ. *Device for charging retorts.*

Claims the feeding mechanism for retorts, consisting of the curved feeding tube provided with a feed hopper, the wheeled shaft for carrying said tube, and a chain, for raising and lowering said tube.

406,409—July 2, 1889. JAMES H. WALKER. *Retort charging device.*

Claims in a retort charging machine, the combination of a carriage, a frame fixed thereon, a fluid pressure cylinder secured to the frame and having a piston and rod connected to a frame fitted to move vertically in the fixed frame, a series of tilting chutes, each supported adjacent to opposite ends upon the fixed and the movable frames, respectively, and stops fixed to the chutes in position to abut against their supports and regulate their degree of horizontal traverse thereon.

423,924—March 25, 1890. ISAAC B. HAMMOND. *Feeding device for ore roasting furnaces.*

Claims as an appliance for an ore furnace, an ore-feeder consisting of a hopper to contain the ore to be roasted, a revoluble fluted cylinder located at the bottom of the hopper and above the furnace floor and adapted to discharge thereon regulated amounts of ore at regulated intervals, and pawl and ratchet mechanism for revolving the cylinder at regulated intervals to a regulated extent, in combination with a reciprocating rake and a connection between said reciprocating rake and the pawl of the pawl and ratchet mechanism, whereby the cylinder is caused to revolve.

425,797—April 15, 1890. CHARLES W. HUNT. *Car for coke.*

Claims the combination, with the iron car for coke or similar incandescent or hot materials, of perforated pipes around the interior of such car near the upper part thereof, and coupling connections for a water supply, whereby the metallic car is protected from injury by a stratum of water caused to pass over its interior surface.

428,466—May 20, 1890. WILLIAM H. DINSMORE. *Device for removing coke from ovens.*

Claims the device, consisting of a frame having the downwardly and rearwardly inclined notches, a transverse rod having its ends seated in said notches, a chain pendent from said rod and movable thereon, a pulley block swiveled to the lower end of said chain, so as to turn freely in any direction, said pulley block having mounted therein a pulley wheel, and a clearing rod fitting in the groove of said wheel and guided thereby, said rod provided on its outer end with a hand piece or ring and on its inner end with an angularly bent scraping blade.

435,891—September 2, 1890. NATHANIEL O. GOLDSMITH. *Coke drawing machine.*

Claims in a coke drawing machine, the combination, with a platform car, of an engine and a swiveled table mounted on the platform, a reciprocating rake supported by the table and having a rack, an engine shaft geared to one of the car axles, a counter shaft rotated by the engine shaft and geared to the rack on the rake, clutch devices for throwing the engine shaft into and out of gear with the car wheel and the counter shaft, and rack and pinion mechanism actuated by the engine for turning the table.

446,086—February 24, 1891. THOMAS SMITH. *Apparatus for extracting coke from ovens.*

These improvements provide first, means for forcing a plate through the door of the oven and under the coke and for then withdrawing the said plate, bringing with it the coke which is to be extracted; second, enable the said plate to be directed to all parts of the oven in succession, so as to withdraw the whole of the coke; third, provide guides for the bar carrying the said plate and for allowing it to be moved horizontally in any direction, and, fourth, provide means for propelling the entire machine along rails in either direction.

447,022—February 24, 1891. GASTON A. BRONDER. *Gas retort discharging apparatus.*

Claims in an apparatus for discharging gas retorts, the combination, with a track, of a carriage mounted on the track and an extensible and contractible rake composed of two parts, each provided with a rake head, one of the parts having a longitudinally sliding engagement with the other part, said parts being controlled in their movements by the movement of the carriage.

448,636—March 24, 1891. ALVA C. COCHRAN. *Coke oven plant.*

Claims in a coke oven plant, the combination, with a series or line of coke ovens having discharging doors, of a platform in front of the doors and about at the level thereof, a subway beneath the platform, and a chute leading in a downwardly inclined direction through the platform to a car in the subway.

456,140—July 21, 1891. JAMES ELLIOTT. *Apparatus for the manufacture of coal gas.*

Claims in a gas producing apparatus, the combination of retorts provided at their front ends with hoppers connected to a mouthpiece by a pipe and at their rear ends with a mouthpiece, with ascension-pipe hole, and opening, corresponding with openings of a cylinder, pivoted to arms, and chargers placed into said retorts and attached to a rod, passing through lids of retorts attached to toothed wheels, acted upon by worm wheels, secured to shafting.

466,569—July 28, 1891. ANDREW HICKENLOOPER. *Gas retort charger.*

Claims in a retort charger, a carriage adjustable to and from the face of the retort bench, two or more fixed charging hoppers arranged in vertical succession with discharge nozzles in a common vertical plane adapted to enter the mouths of two or more retorts simultaneously, a blast distributer to each hopper at the rear of the discharge nozzle, a standpipe upon said carriage having an extensible connection with a reservoir of blast force, and connections between said standpipe and blast distributers.

469,180—February 16, 1892. GEORGE R. WAITE. *Gas apparatus.*

Claims in a gas apparatus, the combination of a bench having retorts, removable cartridges for such retorts, each having a socket or sockets, the elevated track, the trolley confined on such track, the depending rod at its upper end, pivotally united to the trolley frame, and the cartridge-supporting lever between its ends hung from the lower end of such rod.

469,868—March 1, 1892. THOMAS R. OSBOURN. *Apparatus for quenching coke.*

Claims an apparatus for quenching coke by steam, consisting of a closed car, chamber, or other receptacle, adapted to contain coke, provided with a second or external wall which forms with the wall of the receptacle a closed water containing compartment or jacket to receive the heat radiated from the coke, a water supply discharging into said water containing compartment, and steam outlets leading from the upper portion of said water containing compartment and discharging into the coke receptacle.

475,540—May 24, 1892. ANDRÉ COZE. *Apparatus for discharging gas retorts.*

Claims in combination with a suitable traveling carriage and rake and handle consisting of a flexible band or rod adapted to be curved upward, guide rollers for guiding the handle in a vertical direction, and mechanism for propelling such rake and handle into and out of the retort.

476,685—June 7, 1892. JOHN RUSCOE. *Apparatus for charging gas retorts.*

Claims the combination of main frame, scoop-carrying frame movable vertically in the main frame, horizontal driving shaft, connections between the driving shaft and the movable frame for raising and lowering the latter, a vertical shaft and clutch-actuated gearing between the same and the driving shaft, a worm gear on the movable frame, connections between said gear and the scoop for actuating the latter, and a sliding worm on the vertical shaft for actuating the worm gear.

476,686—June 7, 1892. JOHN RUSCOE. *Apparatus for drawing gas retorts.*

Claims in an apparatus for drawing gas retorts, a main frame, a second frame, supported in the main frame, and a rake arranged to slide longitudinally on the second frame, in combination with a chain, connected to the rake, the chain-carrying pulleys, and the worm gear and pinions for driving the same, all mounted on the second frame, the vertical driving shaft, the worm splined on said shaft and capable of sliding up and down thereon, and means for raising and lowering the second frame.

498,755—June 6, 1893. WILLIAM ARROL AND WILLIAM FOULIS. *Apparatus for charging gas retorts.*

Claims in an apparatus for charging gas and other retorts the combination with a frame and a bar pivoted thereon, of a rod mounted on said pivoted bar for tilting the bar and means for reciprocating the rod so connected as to be operated simultaneously by the movement of a suitable actuating device.

498,779—June 6, 1893. WILLIAM FOULIS. *Apparatus for stirring and drawing gas retorts.*

In carrying out this invention mount on the top side of the I iron or steel bar an iron or steel plate, which has also mounted at its under side two stiffening angle iron or steel bars, which may extend the whole length of the plate or not as desired. The said I iron or steel bar has the slipper or carriage mounted on its lower side in such a manner as to enable it to be reciprocated backward and forward by the two horizontal acting hydraulic cylinders and rams as hitherto, but which, in this case, are mounted on the top side of the plate which is formed with two longitudinal slots or openings, through which the pulleys on the ends of the rams work. The said slots also act as guides for the front ends of the said rams which are formed with suitably shaped guide or slipper blocks. Also provide the front end of the raising and lowering cylinder's ram with a guide or slipper block which works on the upright standard of the apparatus, which as well as the plate has wooden or other buffers attached so as to terminate the strokes of the rams and slipper or carriage. Near the front end of the I or steel bar mount preferably a hardened steel block in such a manner as to guide the rake rod or it may be stirrer rod or rods, during their backward and forward movements. Also so shape the race of the automatic drop plate, that when the apparatus is not in use the plate will be nearly in a horizontal plane and so permit of vehicles and such like passing underneath the front end of the apparatus.

534,422—February 19, 1895. GASTON A. BRONDER. *Gas retort charging apparatus.*

Claims the combination in a retort charging apparatus, of a main carriage for running along in front of the retorts, a scoop carriage arranged to run transversely upon the first-mentioned carriage and having two or more scoop supports, scoops upon said supports, and locking devices for locking each scoop either to the scoop carriage or to the main carriage that it may either move with the scoop carriage or leave the latter free to move without it.

563,781—July 14, 1896. JOHN A. MONTGOMERY. *Combined coke drawing, cleaning, sprinkling, and loading machine.*

Claims in a machine for drawing coke from ovens, the reciprocating and laterally moving coke-drawing frame provided with the endless conveyor, the coke-drawing breaker or shovel, the vertical saws, and the vertical and horizontal fingers and their supporting frame, and the racks on the coke-drawing frame, in combination with a frame having a rotary turntable provided with an engine having a drive shaft and pinions thereon which engage the said racks by means of which the coke drawer is reciprocated, and the sprocket wheels to engage and operate the conveyor.

595,089—December 7, 1897. GASTON A. BRONDER. *Machinery for discharging gas retorts.*

Claims in a machine for discharging gas retorts, the combination of a carriage, two or more rakes, a carrier for said rakes and means for moving said carrier backward and forward on said carriage, a lifting bar on said carriage common to the several rakes, a counterbalance lever from which said lifting bar is suspended and the fulcrum of which is movable, mechanism for moving the said fulcrum, means for connecting said rakes with the said carrier and carriage whereby one or more of them may be moved with the carrier while the other or others are held stationary on the carriage and a detachable connection between the fulcrum-moving mechanism and the carrier-moving mechanism.

621,663—March 21, 1899. JOHN A. HEBB. *Coke drawer.*

Claims in a coke drawer, the combination of a rotatable table, an actuating lever and dogs for operating said table and supported thereby, a segmental rack bar engaged by said dogs, a vertically adjustable reciprocating scraper supported by said table, and mechanism carried by said table for operating said scraper.

643,633—February 20, 1900. ANDRÉ COZE. *Apparatus for charging inclined gas retorts.*

Claims in the automatic system for charging inclined retorts, the combination with a charging hopper, of a valve controlling the outlet of said hopper, means for operating said valve, a spring-supported bucket and mechanism for establishing a connection between said valve-operating means and the bucket, whereby the compression of the springs and the descent of the bucket under the load will effect the automatic closure of the delivery valve of the supply hopper when the bucket has received a load sufficient for the charging of the retort.

644,053—February 27, 1900. ALEXANDER E. BROWN. *Coke pusher.*

Claims in an apparatus for charging or drawing coke ovens, open hearth or steel heating furnaces and the like, the combination of a frame or supporting structure, and a pusher bar or ram composed of sectional members, one of which members rests and is movable horizontally upon said frame or supporting structure, upon or against rollers or similar rotating supports or bearings provided for the purpose, and the other of which members rests upon the first named of said members, upon or against like rollers or rotating supports or bearings; sheaves or similar appliances, at the rear and forward portions respectively of said first named member, and chains, or like devices, fastened to the rear portion of said second named member, and, respectively, to the rear and forward portions of said frame or structure, which chains, in one case, pass over said sheave or sheaves at said rear portion, and, in the other case, pass over said sheave or sheaves at said forward portion of said first named member, together with suitable means for actuating said first named member horizontally forward and back on said frame or supporting structure.

645,820—April 3, 1900. WILLIAM FOULIS. *Apparatus for charging retorts.*

Claims in apparatus for charging retorts and for drawing the charges thereof, the combination, with a guide or beam, a rod carrying a charge pushing or withdrawing device, longitudinally movable on the guide or beam, and motor mechanism such as hydraulic cylinders and rams for imparting such movement to the rod, of motor mechanism for raising and lowering the said rod independently of the guide or beam.

647,347—*April 10, 1900.* SAMUEL T. WELLMAN, CHARLES H. WELLMAN, AND JOHN W. SEAVER. *Pusher for coke ovens.*

Claims a coke-oven pusher having a stem composed of sections adapted to slide telescopically one within another, the innermost section carrying the pusher, and connections whereby the movement of an inner section is imparted to the section surrounding it, in combination with a chain connected to the innermost section of said stem, and composed of flat elongated links, a sprocket wheel for actuating said chain, and provision for rotating said sprocket wheel.

668,213—*December 4, 1900.* GASTON A. BRONDER. *Machinery for discharging gas retorts.*

Claims in a machine for discharging gas retorts, the combination, with a carriage and a rake carrier arranged to run therein, of a motor cylinder and a fixed rack and a flying rack all on said carriage, a gear carried by the piston rod of said motor cylinder and engaging with both of said racks, sheaves pivotally attached to said carriage, sheaves pivotally attached to said flying rack, and a rope connected at two points with said carriage and also connected with the rake carrier and running on said several sheaves.

668,234—*February 19, 1901.* MAXIMILLIAN M. SUPPES. *Apparatus for use in the manufacture of coke.*

Claims the combination of a coke oven having a coke making chamber therein, a vessel of substantially the same internal section as that of said chamber, a recess in the foundation wall at one end of the said oven, a flange at one end of said vessel adapted to enter said recess, a projection from a central portion of said vessel, and a fixed stop adapted to be engaged by said projection.

669,377—*March 5, 1901.* ADDISON M. BACON. *Coke drawing apparatus.*

Claims a coke drawing apparatus comprising a fixed support, a supplemental support on which the apparatus may be moved, means for moving one of the said supports vertically, a hollow drawing tool adapted to be projected and retracted on said support, and means for passing a stream of water to said tool.

676,025—*June 11, 1901.* GASTON A. BRONDER. *Gas retort charging apparatus.*

Claims in a retort charging apparatus, the combination of a main carriage, a hopper mounted on the same, a scoop carriage operating on the main carriage, coal scoops carried on the scoop carriage, scraper frames with scrapers actuating in the scoops, locking bar support angles secured to the uprights of the main carriage and to the hopper, locking bars fulcrumed to the locking bar support angles for detaining the scrapers in the retorts, tipping cams secured to the horizontal braces of the scoop carriage for unlocking the locking bars, adjusting cams attached to the locking bar support angles, friction and adjusting rollers secured to the scoops actuated by the adjusting cams to obtain the proper positions for the scoops to enter the retorts.

682,793—*September 17, 1901.* EDWARD DRORY. *Means for charging gas retorts.*

Claims the combination with sets of furnaces arranged to have a clear space between, separate roofs for each set of furnaces, structural ironwork supporting the ends of the roofs and connected above the ground to leave a free passage between the buildings, two sets of cantalevers projecting into each building, coal receptacles above and proximate, the furnace fronts supported on the upper sets of cantalevers, discharging hoppers on said receptacles, a track supported by the upper set of cantalevers, a charging vessel arranged to move on said track, and a platform beneath the coal receptacles supported by the lower sets of cantalevers.

687,600—*November 26, 1901.* GASTON A. BRONDER. *Coal hopper for gas retort chargers.*

Claims a hopper, pushers extending between the sides of the hopper, consisting of a plate curved approximately at right angles, sliding brackets supporting the said curved plate, brackets fastened to the plates, links pinned to the brackets; in combination with cross shafts, cranks fastened to said shafts, links connecting the cranks and the brackets fastened to the pushers, levers fastened to the cross shafts, handle bars pinned to the levers.

691,148—*January 14, 1902.* WALTER KENNEDY. *Plant for coke making.*

Claims in an apparatus for manufacture of coke, the combination of two lines of hearths, two series of two or more ovens movably arranged on the hearths, a car movable between the lines of hearths, a bridge movably mounted on rails parallel with the hearths, a buggy movably mounted on the bridge, and hoisting mechanism arranged on the buggy and adapted to be connected to the ovens in turn.

692,746—*February 4, 1902.* SAMUEL T. WELLMAN, CHARLES H. WELLMAN, AND JOHN W. SEAVER. *Combined charging and discharging device for coke ovens.*

Claims a coke oven or retort charging machine having a movable coal carrier whereby the charge of coal is carried into the oven or retort, and a pusher combined with said coal carrier, whereby the charge of coke may be pushed from the oven at the same time that the fresh charge of coal is being introduced into the same.

695,970—*March 25, 1902.* EDWARD N. TRUMP. *Coke handling apparatus.*

Claims the combination, with an oven, of a device for discharging the body of coke in a substantially horizontal plane from the oven, and means provided with a platform of a length greater than the width of the body of coke for receiving and retaining the coke, said means being movable for moving the platform crosswise of the path of the body of coke during the discharge of said body of coke, and cooperating with said device for causing the advancing end portions of the body of coke to become detached therefrom in masses which are caused to tumble or fall from the advancing body of coke successively directly upon the platform, and to become distributed on said platform in a broken condition and in a layer of substantially uniform thickness extending crosswise of the path of the body of coke.

705,656—*July 29, 1902.* EDWARD DRORY. *Means for charging gas retorts.*

Claims the combination, with furnaces arranged to have a clear space between them, independent roof structures, posts to support the roof structures, beams connecting the posts supporting the independent roof structures and coal bins supported on said beams within the free space between the roof structures.

707,979—*August 19, 1902.* LÉON BERTRAND. *Apparatus for quenching or cooling coke.*

Claims, in an apparatus for quenching or cooling coke, the combination, with a tank provided with a closed casing, of a hopper suitably attached to said tank, means in the casing of said tank for continuously discharging coke, means in said tank for submerging all the coke fed therein to, and means in said tank for carrying off the fluid generated by the coke while being immersed in the liquid contained in said tank.

707,535—*August 19, 1902.* JOHN WRIGHT SEAVER. *Process of manufacturing coke.*

Claims the process of manufacturing coke, consisting in assembling the charge to be coked, assembling the charge and the dome, moving the assembled charge and dome onto a fixed hearth, and coking the charge.

707,686—*August 26, 1902.* DAVID FERGUSON. *Coke drawer.*

Claims, in a coke drawer, a frame, a drum mounted therein, a reach rod, a flexible device operatively connecting the drum and the rod, a conveyor, disconnectible driving connections between the conveyor and the drum, and means secured to the rod to which power may be applied for driving the rod and the drum when the rod is entering the coke oven.

710,643—*October 7, 1902.* JOHN F. WILCOX. *Coal ramming and transfer apparatus.*

Claims the combination, in a coking plant, of a ramming station, a plurality of rammers and ramming boxes, a series of ovens, a main track for the delivery of charges to the ovens, and auxiliary tracks for the delivery of the ramming boxes to the main track.

713,413—*November 11, 1902.* ALFRED ERNST. *Charging device for coke ovens.*

Claims the combination, in a charging hopper for coke oven charging machines, of sides movable from and toward each other, a longitudinally movable bottom, and means whereby said longitudinal movement of the bottom is caused to effect expansion or contraction of the sides of the hopper.

713,648—*November 18, 1902.* HUGH KENNEDY. *Coke oven.*

Claims, in combination with a coking hearth, a platform movable upwardly and downwardly below the level of said hearth, and a coke oven movable transversely to and from the hearth and platform.

715,094—*December 2, 1902.* LÉON BERTRAND. *Apparatus for discharging retorts.*

Claims, in an apparatus for discharging coke from gas retorts, a plurality of extensible sections, operating means for advancing one of said sections, means for locking said section to the next succeeding section, means for releasing said operating means; and operating means acting upon the last-mentioned section for advancing both of said sections.

716,201—*December 16, 1902.* JOSEPH DE BROUWER. *Apparatus for charging retorts.*

Claims a projecting apparatus for charging coal into retorts, comprising a rotary projector, an endless belt, a frame carrying them, said frame being adapted to be oscillated to vary the trajectory of the projected coal.

717,884—*December 30, 1902.* GASTON A. BRONDER. *Gas retort charging apparatus.*

Claims, in a retort charging apparatus, the combination of a scoop, a plow on the scoop, a scraper frame arranged to slide on the scoop, scrapers extending from the said frame and into the scoop, openings in the scrapers, covers over the said openings arranged to open the said openings by the plows bearing therein.

717,440—*December 30, 1902.* GEORGE H. McCRACKEN. *Unloading mechanism for coke ovens.*

Claims the combination, with a coke oven, of a rotatable bottom therefor, a car movable at the side of the oven, mechanism interposed between the car and rotatable bottom for imparting movement to the latter, and means located on the car whereby the interposed mechanism is operated to rotate the rotatable bottom.

717,575—*January 6, 1903.* WALTER RALPH HERRING. *Apparatus for charging inclined retorts.*

Claims, in apparatus for charging retorts, the combination, with a chute having guide rails at its lower part, of a hood slidable on the said rails longitudinally of the retorts, an inclined shoe, links pivoting the lower part of the said shoe to the said hood, and means for adjusting the position of the upper end portion of the shoe within the said hood.

720,065—*February 10, 1903.* IRWIN W. PIKE. *Apparatus for cooling coke, etc.*

Claims, in an apparatus of the character recited, the combination of a water-containing tank, a trackway leading into and out of the same, a truck upon said trackway, a hood closed except at the bottom and enclosing the top sides and ends of said truck, and having its lower end beneath the surface of the water in said tank, together with means for flowing water over said hood.

721,519—*February 24, 1903.* WILLIAM S. JONES AND JOHN P. DONOHOE. *Coke drawer.*

Claims a mechanical means for drawing coke, comprising a main frame, a support for the operator, movable on the main frame to and from the oven, a scraper holder mounted on said support and adapted to pull the scraper out with it as the support is moved away from the oven.

721,952—*March 3, 1903.* WALTER RALPH HERRING. *Gas retort discharging apparatus.*

Claims an apparatus for use in discharging inclined gas retorts, and comprising a carriage mounted on wheels, a body erected or suspended thereon having a vertical chute and an inclined chute, a flap hinged upon a shaft within said body so as to control the inlet to said chutes, means for operating said flap, a swing box carried upon a shaft within said vertical chute and having an extended central partition whereby the direction of discharge from the vertical chute may be regulated, means for adjusting the position of said swing box, a tar screen, and a rail carried by supports.

722,509—*March 10, 1903.* BURTON J. MATTESON. *Coke drawing machine.*

Claims, in a machine of the class described, a laterally movable drawbar, a shaft, mechanism for oppositely rotating said shaft, a spherical portion fixed to said shaft, and a power transmitting member for actuating said drawbar, having a spherical seat to receive said spherical portion, and rotative with the latter.

723,479—*March 24, 1903.* EDWIN A. MOORE. *Coke pusher.*

Claims a coke pusher having an extensible jib pivotally secured at its lower end to the frame of a car, and provided with revoluble carriers, in combination with a pusher bar supported by said jib and carriers, and provided with means for projecting and retracting the jib.

723,403—*March 24, 1903.* FREDERIC W. C. SCHNIEWIND. *Double coke pusher.*

Claims a coke pusher provided with two opposite balancing pusher bars, means for supporting said bars, and a separate motor for each bar, whereby the bars may be reciprocated simultaneously or independently of each other; in combination with two opposite ovens.

725,760—April 21, 1903. EDWIN A. MOORE. *Construction of coke ovens.*

Claims a coke oven having rails on each side thereof, in combination with a coal charging car having laterally movable wheels engaging said rails.

727,790—May 12, 1903. JOHN A. HEBB. *Coke drawing machine.*

Claims, in apparatus for drawing coke, the combination with a reciprocating beam, of a pivotally attached rake adapted to be folded backwardly by contact with the coke, a spring device located remotely from the rake, and connections between the spring device and rake by which the rake is extended.

727,942—May 12, 1903. JOHN A. HEBB. *Coke drawing machine.*

Claims, in a coke drawing machine, the combination of a main framework provided with supporting wheels, a main driving shaft, a countershaft at right angles thereto, a central vertical shaft, gearing by which motion is transmitted from the main shaft to the countershaft and vertical shaft, respectively, a turntable mounted on the upper framework, a reciprocating beam provided with a rake head, means for transmitting reciprocating motion to the beam from the vertical shaft, means for raising and lowering the end of the beam, means for rotating the turntable, and means for moving the framework along the track.

727,943—May 12, 1903. JOHN A. HEBB. *Coke drawing machine.*

Claims, in apparatus for drawing coke, the combination, with a reciprocating beam, of a pivotally attached scraper adapted to be folded backwardly by contact with the coke, a counterweighted lever pivoted to the beam, and a connection between said counterweighted lever and the scraper by which the scraper is extended.

728,101—May 12, 1903. JOHN A. HEBB. *Coke drawing machine.*

Claims, in a coke drawing machine, mechanism for transmitting longitudinal movement to the beam, consisting of a driving shaft, a driving pinion secured to the shaft, bevel wheels loosely journaled on the shaft and provided with clutch portions, clutch devices in spline engagement with the shaft adapted to engage said portions, and means for driving the toothed wheels in opposite directions.

728,102—May 12, 1903. JOHN A. HEBB. *Coke drawing machine.*

Claims, in a coke drawing machine, mechanism for raising and lowering the beam, consisting of a crank, arms connected therewith, and provided with means for engagement with the beam, a shaft, and gearing for imparting movement to the crank arm and beam in either direction.

728,168—May 12, 1903. JOHN A. HEBB. *Conveying mechanism for coke drawing machines.*

Claims, in combination with a coke drawing machine provided with a longitudinally movable rake; a transversely arranged receiving conveyor, an independent delivery conveyor at an angle thereto, and means for driving both conveyors.

729,259—May 26, 1903. LÉON BERTRAND. *Apparatus for charging retorts.*

Claims the combination of a motor; a charging device operated by said motor; a feed device adjacent to said charging device; and means, thrown into operation by said feed device, for reducing the speed of said motor.

731,251—June 16, 1903. CHARLES H. WELLMAN, ALFRED ERNST, AND FREDELLIA H. MOYER. *Combined charging and discharging device for coke ovens.*

Claims the combination of the movable hopper bottom of a coke oven charging machine, with a pusher plate and one or more brace bars therefor, both the plate and its brace bar or bars being pivotally mounted upon the forward end of said hopper bottom whereby they can be swung into horizontal position for withdrawal beneath the charge of coal in the oven.

731,252—June 16, 1903. CHARLES H. WELLMAN AND ALFRED ERNST. *Apparatus for pushing coke from coke ovens.*

Claims the combination, in a coke oven pusher, of a double ended pusher bar, a structure upon which said bar is mounted so as to be projected from either side of the machine, and means for imparting longitudinal movement to the bar.

731,374—June 16, 1903. JAMES B. LADD. *Coal compressing device.*

Claims, in a coal compressing device, the combination of a receptacle comprising a movable bottom, a hinged front end, a removable back end, a hinged top, and means for locking said parts in fixed relative position, laterally movable sides adapted to have a forward contracting and receding movement, means whereby said forward movement of the sides is imparted to the members above recited, and means whereby the forward movement of the sides is caused.

731,911—June 23, 1903. JAMES ELLWOOD JONES. *Machine for discharging coke ovens.*

Claims a coke puller comprising an underworking wedge-like scraper, movable over the bottom of a coke oven and operative on its instroke to loosen coke for withdrawal, and means adjustable after the instroke to engage and hold loosened coke.

731,912—June 23, 1903. JAMES ELLWOOD JONES. *Mechanism for discharging coke ovens.*

Claims in a coke puller the combination of an underworking scraper movable over the bottom of a coke oven and provided with means for loosening the mass of coke under which it passes on the instroke from the caked mass of coke within the oven, and an overworking claw connected therewith and adapted to close over said scraper for grasping the loosened coke on the outstroke.

731,913—June 23, 1903. JAMES ELLWOOD JONES. *Machine for discharging coke ovens.*

Claims in a coke puller the combination of an underworking wedge-like scraper movable over the bottom of a coke oven and adapted on its instroke to loosen coke for withdrawal, a swinging coke grasper hinged to said scraper and means connected with the underside of said grasper for adjusting it into holding position on the outstroke.

735,092—July 7, 1903. PHILIP B. HASBROUCK. *Coke oven operating apparatus.*

Claims a coke oven operating apparatus comprising a movable supporting structure, a pusher or ram carried on said structure, screw shafts, means for actuating the screw shafts, means mounted on the screw shafts arranged to travel thereon, said pusher or ram flexibly connected with said latter means.

743,037—October 20, 1903. WILLIAM KERNS. *Coke drawer.*

Claims a device comprising in combination a frame or casing designed to be extended into a coke oven, means for gradually advancing the same, an endless conveyor, an incline extending from the end of the frame, a clawer for forcing the coke up such incline, and means for actuating such clawer.

746,055—December 8, 1903. DAVID FERGUSON. *Coke drawer.*

Claims in a mechanical rake or drawer a drawer bar, a rake carried thereby and having movement transversely thereof, means connected to said rake and to said bar which initially causes the rake to travel transversely of the bar and when the travel of the rake has reached a limit causes the bar with the attached rake to travel longitudinally.

747,172—December 15, 1903. JOHN HAUG. *Apparatus for compressing and charging coal into coke ovens.*

Claims in a device means for compressing the coal and means for forming depressions on the lower side of the cake of compressed coal.

749,058—January 5, 1904. JOHN A. HEBB. *Coke drawing machine.*

Claims in a coke drawing machine the combination with a longitudinally movable beam provided with a scraper, of screw mechanism for raising and depressing the beam.

752,904—February 23, 1904. CHARLES WALLACE HUNT. *Apparatus for handling coke.*

Claims the combination of a bench of retorts, a floor having an opening through which the coke discharged from the retorts may fall, means to quench the coke as it falls through said opening, a chamber beneath said opening, and an exhaust device connected to said chamber to withdraw the steam from said chamber as the coke is quenched

753,142—February 23, 1904. JOSEPH KERSHGENS. *Machine for discharging coke from ovens.*

Claims in a machine for discharging coke from ovens the combination with a supporting frame, of a push bar arranged for reciprocation on said frame and adapted to be projected from the side of the frame, means for projecting said push bar normally disengaged from the push bar, and separate means for imparting initial movement to the push bar to bring it into engagement with said projecting means.

754,253—March 8, 1904. SAMUEL T. WELLMAN, CHARLES H. WELLMAN, JOHN W. SEAVER, AND THOMAS R. MORGAN. *Machine for charging coke ovens.*

Claims in a coke oven charging machine a hopper with sides adjustable from and toward each other, slides carrying an adjustable side of the hopper and laterally adjustable upon the frame of the machine, and means for effecting simultaneous adjustment of all of said slides.

755,154—March 22, 1904. EDWIN A. MOORE. *Coke quenching and bleaching apparatus.*

Claims a coke quenching and bleaching apparatus, consisting of a receptacle provided with laterally movable doors at both its ends, means for supplying water thereto, an outlet for water at the bottom and at one end of the receptacle, an outlet for steam, and means for controlling said outlet.

756,225—April 5, 1904. WALTER WILLIAM FIDDES. *Gas retort charger and discharger.*

Claims a discharging charger for drawing and charging gas retorts consisting of the two side plates, distance pieces between the two side plates near their tops, and division plates pivoted between the two side plates and free to swing forward toward the front of the charger, and a bed plate on which the parts rest.

756,696—April 5, 1904. ADOLF PFEIFFER. *Apparatus for feeding gas retorts.*

Claims the combination with two parallel revolubly mounted feed tubes provided with discharge openings, and means for rotating the tubes in opposite directions to bring their openings into filling and discharging position, of two revolubly mounted valves, suspended between the upper sides of the tubes in register with their openings, whereby the valves will lie close together when the tubes are filled but will separate and overlie the closed sides of the tubes when they are discharging their contents.

757,283—April 12, 1904. ANDREW JACKSON DOSS. *Coke puller.*

Claims a coke puller comprising an underworking wedge-like hollow scraper provided with an opening in its upper part and with a hollow shank, an actuating bar extending through said hollow shank into said hollow scraper, and an adjustable coke holder consisting of a plate hinged to said bar and thrust into operative position through said opening.

757,312—April 12, 1904. JAMES ELLWOOD JONES. *Coke puller.*

Claims a coke puller comprising an underworking wedge-like scraper movable over the bottom of a coke oven, an adjustable coke holder hinged to said scraper and provided with a crank arm, a lever engaging said crank arm, and an actuating rod connected with said lever for swinging said coke holder into operative position.

761,251—May 31, 1904. CHARLES S. PRICE. *Coke quenching apparatus.*

Claims the combination with a retort coke oven, of a quenching apparatus consisting of a covered receptacle of considerably greater width than the coke oven, said apparatus being provided with a door opening adapted to register with that of the coke oven, a series of water spray pipes mounted within the upper portion of said receptacle, and means for supplying and regulating the flow of water therethrough.

765,809—July 26, 1904. GASTON A. BRONDER. *Gas retort charging apparatus.*

Claims in a scoop of a retort charging apparatus the combination of a scraper frame with scrapers arranged to slide on the scoop, covers arranged to rise, lower and swing on the scrapers, a plow with rising and horizontally diverging sides on the scoop, and arranged to pass under the scrapers.

768,067—August 23, 1904. WILLIAM H. McCONNELL. *Coke extractor.*

Claims in a coke extractor the combination of a ram carriage arranged to rotate on suitable rollers on the bed plate of the machine; a suitable bearing attached to the bed plate around which the carriage rotates, a driving shaft passing through and rotating in said bearing, a ram sliding in the carriage actuated by the rotation of the shaft; suitable vertical guiding rollers in the carriage for guiding the horizontal movement of the ram in the carriage; horizontal rollers at either end of the carriage for guiding the vertical movement of the ram; and devices substantially as described whereby the ram carriage and ram are rotated on the bed plate.

774,830—November 8, 1904. EDWIN A. MOORE. *Coke quenching and bleaching apparatus.*

Claims a receptacle for hot coke and means for supplying water thereto; in combination with means for collecting and condensing steam generated in treating the coke.

775,177—November 15, 1904. JAMES ELLWOOD JONES AND HARRY KING. *Coke puller.*

Claims a coke puller comprising an underworking wedge-like scraper movable over the bottom of a coke oven, a plurality of coke holders connected therewith and adjustable after the instroke to enlarge the capacity of the scraper on the outstroke, and means for adjusting said coke holders.

775,178—November 15, 1904. JAMES ELLWOOD JONES AND HARRY KING. *Coke puller.*

Claims a coke puller comprising an underworking wedge-like scraper movable over the bottom of a coke oven and provided with a slot or opening, an adjustable arc shaped coke holder disposed within said scraper, and means for thrusting said arc shaped coke holder outward into operative position to hold coke on the outstroke.

775,179—November 15, 1904. JAMES ELLWOOD JONES. *Coke puller.*

Claims a coke puller comprising an underworking scraper, a coke holder comprising a swinging plate hinged to said scraper and provided with a toothed segment, an actuating rack bar and a pinion connecting said rack bar with said segment.

775,108—November 15, 1904. JAMES ELLWOOD JONES. *Coke puller.*

Claims a coke puller comprising a frame and a plurality of swinging wedge-like extractors disposed one behind another and adjustable to horizontal position to serve as coke looseners on the instroke and to upright position to serve as coke holders on the outstroke, and means for swinging said extractors into different positions to adapt them to perform their separate functions in succession.

775,182—November 15, 1904. HARRY KING. *Machine for discharging coke ovens.*

Claims in a coke puller the combination of an underworking wedge-like scraper movable over the bottom of a coke oven and adapted on its instroke to loosen coke for withdrawal and on its outstroke to withdraw loosened coke, a swinging coke grasper provided with a rigid arm extending downward therefrom, a slide bar connected with said rigid arm, and another slide bar having a link connection with said rigid arm.

775,183—November 15, 1904. HARRY KING. *Coke puller.*

Claims a coke puller comprising an underworking scraper adapted to operate on its instroke to loosen coke for withdrawal and on its outstroke to withdraw loosened coke, a tilting plate pivoted about midway of its length to the body of said scraper and adapted to serve in a forwardly inclined position as a wedging or lifting surface for said scraper and in the oppositely inclined position as a coke grasper or holder, and means for tilting said plate.

775,196—November 15, 1904. FRANK CHASE SOMES. *Mechanical coke puller.*

Claims a coke puller comprising an underworking scraper adapted to operate on its instroke to loosen coke for withdrawal and on its outstroke to withdraw loosened coke, and a sliding extension plate movable on said scraper and adapted to receive and hold the loosened coke which falls thereon on the outstroke.

775,197—November 15, 1904. FRANK CHASE SOMES. *Coke puller.*

Claims a coke puller comprising an underworking scraper adapted to operate on its instroke to loosen coke for withdrawal and on its outstroke to withdraw loosened coke, a sliding extension plate movable on said scraper and adapted to receive and hold the loosened coke which falls thereon on the outstroke and means under the control of the operator for sliding said plate into extended position to receive coke falling from said scraper on the outstroke.

775,211—November 15, 1904. ANDREW JACKSON DOSS. *Coke oven discharging machine.*

Claims in a coke drawing machine the combination of a track, a coke puller carriage adapted to travel on said track toward and from a coke oven, a coke puller supported on said carriage and adapted to travel therewith to effect the coke pulling operations, means for reciprocating said coke puller carriage, and mechanical means on said carriage and under the control of the operator for otherwise manipulating said coke puller.

775,221—November 15, 1904. HARRY KING. *Coke puller.*

Claims a coke puller comprising an underworking scraper adapted to operate on its instroke to loosen coke for withdrawal and on its outstroke to withdraw loosened coke, a swinging coke grasper hinged to said scraper and provided with a rigid arm extending downward within said scraper from the pivot of said coke grasper, and a slide rod having a pin and slot connection with said rigid arm for swinging it into open and closed position.

775,266—November 15, 1904. ANDREW JACKSON DOSS. *Implement for discharging coke ovens.*

Claims an implement for use in the discharge of a coke oven comprising a coke loosener having a doubly inclined upper face adapted to slide under the coke on the inward and outward strokes and provided with a shank adapted for detachably engaging a handle.

775,275—November 15, 1904. HARRY KING. *Coke puller.*

Claims in a coke puller the combination of a coke puller bar, a coke puller blade having a pivotal connection with said bar and adapted to swing outward approximately in line therewith to form a wedge-like coke loosener or to swing substantially at right angles to said bar to form a claw, and means for swinging said blade into its different positions.

780,208—January 17, 1905. JAMES B. LADD. *Charging device for coke ovens.*

Claims in a coke oven charging machine the combination of a longitudinally movable peel, a threaded shaft rotatably mounted diagonally across the longitudinal extension of the peel, and means connected with the peel for cooperating with the shaft to cause the movement of the peel upon the rotation of the shaft.

783,637—February 28, 1905. JAMES B. LADD. *Coal compressing and charging device.*

Claims in combination with a coal compression box, having a horizontally movable side, independently movable, power operated mechanism for automatically charging said box exactly full at a single operation.

786,623—April 4, 1905. FREDERICK D. BUFFUM. *Machine for drawing coke.*

Claims a coke drawing machine comprising in its construction a shovel having a flat bottom and mounted so as to be rotated or oscillated on an axis extending lengthwise of said shovel, means for reciprocating the said shovel, and power mechanism for turning it on said axis.

790,336—May 23, 1905. FRED R. STILL. *Coke quenching apparatus.*

Claims in a coke quenching apparatus the combination of a substantially horizontally extending receptacle having formed lengthwise therein a series of fill openings and a corresponding number of discharge outlets, and a draft conduit communicating with the receptacle and adapted to remove the gases and vapors produced by the receptacle contents.

791,685—June 6, 1905. SAMUEL J. FOWLER. *Apparatus for charging retorts.*

Claims a projecting apparatus comprising a rotary wheel having provisions for admitting material adjacent its axis and ejecting the same at its periphery, an endless belt surrounding a greater portion of said wheel in contact with the periphery thereof and cooperating with said wheel to permit the material to be projected through the space not surrounded by the endless belt.

793,238—June 27, 1905. CARL SCHROETTER. *Discharger for coke ovens.*

Claims a discharger for coke ovens and retorts adapted to remain in the coking chamber during the coking operation and comprising a metal plate equal in width to the oven and bent at substantially right angles to form a horizontal member lying upon the sole of the retort and a vertical member of substantially the height of the charge, a similarly bent bar constituting a reinforcing rib secured to said plate longitudinally and substantially centrally thereof, and a pair of tie rods uniting the free ends of said horizontal and vertical members.

793,355—June 27, 1905. JOSEPH DE BROUWER. *Apparatus for discharging coke.*

Claims an apparatus for pushing coke from through retorts, consisting of a rigid rod-bar, toothed links attached thereto, forming a rack flexible in one direction only, means on which the rack may be folded up, and an operating pinion meshing with said rack.

793,773—July 4, 1905. CHRISTIAN EITLE. *Gas retort charging machine.*

Claims in a machine for filling retorts a centrifugal drum, rotating blades mounted within the drum, a feed orifice, a feed worm in the feed orifice, a storage receptacle, a raising and lowering device, and a deflecting plate.

794,960—July 18, 1905. HERBERT JOHN TOOGOOD. *Charging machine for gas retorts.*

Claims in a retort charger the combination, with a charging chamber provided with an inlet and an outlet, of movable feeding devices arranged in the said chamber, and means for accelerating the motion of the said feeding devices in their passage from the said inlet to the said outlet.

795,202—July 18, 1905. LEON DEGRAND. *Apparatus for discharging retorts.*

Claims in an apparatus for discharging retorts mechanism for providing a properly-timed operation of the apparatus, the said mechanism consisting of a series of racks, all of which are movable and provided with locking means to couple the same for unitary sliding movement at intervals, said locking means consisting of pins projecting from and openings formed in the several racks, the pins consecutively and loosely engaging the openings of the racks and also operative in part to prevent one rack from being driven by the friction of an adjacent rack before the latter rack is at the end of its stroke.

801,492—October 10, 1905. JOHN WEST. *Gas retort charging machine.*

Claims in a gas retort charging apparatus the combination of a carriage, means to move the same, a ram, the stem of which is provided with a rack, a chain drum, a shaft having parallel wheels mounted thereon over which the chain on said drum operates, a gear mounted on said last mentioned shaft adapted to mesh with a gear mounted upon a shaft in advance of said last mentioned shaft, a cam adapted to operate a clutch mechanism alternately in different directions laterally, in combination with mechanism to prevent the cam shaft operating until the proper time.

803,586—November 7, 1905. JOHN S. HAM. *Coke extractor.*

Claims in a coke extractor the combination of a truck mounted on wheels, a ram carriage arranged to rotate on the truck and a ram or bar arranged to move horizontally thereon, the rear end of which is composed of parts joined together so that the ram is rigid at the end toward the coke oven and rigid or flexible at the outer end, as may be desired.

804,670—November 14, 1905. HARRY FRANCIS PEARSON. *Coke puller.*

Claims in a coke puller the combination of a movable support, a turret mounted thereabove, a motor upon said turret, a device for swinging said turret upon said support, and means for connecting said device to said motor.

Subclass 6. Coke Ovens—Doors.

184,473—November 21, 1876. HENRY A. LAUGHLIN. *Improvement in furnace doors.*

A cast iron door body having openings therein, in combination with removable panel plates covering the openings; a series of studded panel plates, in combination with a door body having transverse ribs and openings; a plastic filling, in combination with studded plates and paneled door body; a shoe, in combination with an upright, the two interlocking, and uprights connected at their upper ends by a crossbar, in combination with one or more tie rods passing through the crossbar.

244,528—July 19, 1881. CHRISTOPHER BEAM. *Door for coke ovens.*

Claims in a coke oven a chambered door composed of a lower part, constructed with an exterior perforated wall of iron, having flanges, and an inside sectional wall of fire clay, and upper solid arched part of iron, hinged to the top of the chambered lower part, and adapted to open outwardly in a vertical plane.

253,235—February 7, 1882. WILLIAM H. STRICKLER. *Oven and furnace door.*

Claims in a furnace door, the combination, with a metallic front, of a fire brick back bolted thereto, the said front and back being some distance apart, and the heads of the bolts embedded in the fire brick.

287,285—October 23, 1883. JOHN HERRON AND ROBERT T. WRAY. *Coke oven door and frame therefor.* (*Reissued June 3, 1884, No. 10,484.*)

Claims the combination of door frame, inclosed fire brick, movable iron plate provided with handle, crossbar, and wedge, connected to chain; also a door frame provided with refractory brick filling and an air inlet above the arch or upper bar.

288,761—November 20, 1883. WILLIAM H. BECKWITH. *Coke oven door.*

Claims a coke oven door, consisting of a lower section, for permitting the charge to be withdrawn, and upper section for permitting the charge to be leveled without escaping from the oven, and air inlet doors applied to openings at the top of the upper section, and adapted to be opened and to stand open to a greater or less extent, according to the required supply of air to the oven.

294,845—March 11, 1884. WALTER A. BLYTHE AND JAMES HENDERSON. *Coke oven door.*

Claims the combination of oven, horizontal water pipe arranged above the doorway and connected with a water supply, door provided with a water jacket, connecting pipe depending from the water pipe and arranged to deliver water into the water jacket, and hanger bar journaled at one end on the water pipe and having its other end connected with the door.

300,256—June 10, 1884. JOHN HERRON AND ROBERT T. WRAY. *Door for coke ovens.*

Claims the combination of a frame and brick work built therein, with a double door, which is placed inside of the door frame and which is provided with means for regulating the passage of air up through the door, and a peephole.

307,258—October 28, 1884. WILLIAM H. BECKWITH. *Coke oven door.*

Claims, in combination with an oven door provided with guides and air inlet, a slide having its ends mounted in said guides and provided with a lug and a lever, pivoted to the door, and having an eccentric head bearing against the lug.

307,720—November 4, 1884. JOHN HERRON. *Door for coke ovens.*

Claims a door for coke ovens, composed of two separable sections, each one of which consists of a metallic shell or frame, a filling of fireproof composition, and a wire netting for holding the composition in place, the upper section being provided with depending strips for catching against the face of the lower section.

374,943—December 20, 1887. JOHN J. DAVIS. *Coke oven door.*

Claims the combination, with a coke oven, of a door plate seated removably on the bottom of the discharge opening of the oven and reaching part way the height of said opening, and provided with a top ledge, and a shelf, supported with its inner edge removable on said ledge.

441,083—November 18, 1890. JOHN WATERS. *Furnace door.*

Claims a furnace door, consisting of the combination, with a frame, of a brick having an undercut groove, and a removable fastening device comprising a flange, adapted to fit said groove, and a stud, and means for securing the latter to said frame.

578,510—March 9, 1897. CHARLES WILSON GARLAND. *Door for coke ovens.*

Claims an oven door, comprising the upper and lower pairs of doors hinged at their outer edges and provided with perforations, the lower doors being provided at their upper and lower edges with openings and removable linings detachably interlocked with the doors, forming intervening spaces between them and the doors and provided with openings corresponding with the openings in the doors.

601,403—March 29, 1898. GUSTAV HILGENSTOCK. *Coke oven door.*

Claims a coke oven in combination with a door lined with refractory material and having a combustion chamber formed therein, with passages for the introduction of gas and escape of products of combustion.

725,745—April 21, 1903. EDWIN A. MOORE. *Coke oven door.*

Claims a coke oven door, in combination with a plurality of clamping bars, movable links, a shaft on which the clamping bars are mounted, and a shaft which passes through the movable links, and means on each of said shafts for forcing the door to its seat by revolving the shafts.

725,746—April 21, 1903. EDWIN A. MOORE. *Water-cooled coke oven door.*

A hollow rectangular coke oven door having communicating water chambers therein, and a hollow rectangular door frame provided with water chambers, in combination with a supply pipe, a connection between said pipe and the door, a connection between the supply pipe and the door frame, a discharge pipe, a connection between the discharge pipe and the door, and a connection between said pipe and the door frame.

725,747—April 21, 1903. EDWIN A. MOORE. *Water-cooled coke oven door frame.*

Claims a hollow coke oven door frame provided with partitions extending from the upper end of the frame down through the sides and part way across the lower end toward the transverse center thereof, an intermediate partition in the lower end of the frame, a water supply and a water discharge opening at the upper end and on opposite sides of the transverse center of the frame.

736,281—August 11, 1903. GEORGE D. MACDOUGALL. *Coke oven door.*

Claims in an oven the combination of the door casing having the packing, the buckstays having the inclined or beveled vertical edge flanges, the door having the inturned flange engaging said packing, the exterior rotary latch levers pivoted to the door and having the beveled end rabbets engaging the beveled flanges of said buckstays to press the door flange against said packing.

750,323—January 26, 1904. BIRDINE TROUTMAN. *Coke oven door.*

Claims the combination, with the doors, of a lug formed upon the lower door, and the upper door frame having a recess within which the lug is adapted to be received and lock the lower door, said pin also acting as a fulcrum for the coal leveling implement.

Subclass 7. Coke Ovens—Dumping Bottoms.

50,558—October 24, 1865. JACOB BOWERS. *Improvement in coke ovens.*

Claims placing the opening or doorway for discharging the contents of the oven below the level of the bottom of the oven, in combination with a moving bottom, so constructed and arranged as to make a passage from the interior of the oven to the doorway when the bottom is tilted and to close the communication when the bottom is shut down.

129,803—July 23, 1872. JULIUS ERICHSEN AND JÖRGEN GEORG MAARDT. *Improvement in coke ovens.*

Claims a hinged bed, in combination with ovens or fire chambers, and mechanism, for raising and lowering the front edge of the bed; also coke carts made with an inclined front, in combination with the hinged bed.

150,808—May 12, 1874. HENRY ZAHN. *Improvement in furnaces and processes for manufacturing coke and gas.*

Claims the combination of a coke oven, in which the waste products of combustion are partially or wholly confined, with a working chamber or heating grate, by means of a flue or flues, which serve to conduct and control the current of these products into the fire of said chamber or grate, and whereby said waste products of the first combustion are utilized.

151,513—June 2, 1874. LEWIS SCHANTL. *Improvement in coke ovens.*

Claims the combination of a coke oven, having circular flue and lateral flues, with an oscillating bottom, trunnions, plate, and pit.

163,533—May 18, 1875. LEWIS SCHANTL. *Improvement in coke ovens.*

Claims the combination, with a coke oven, of a bottom having a vertical and oscillating movement.

166,846—August 17, 1875. LOUIS CHARLES ERNEST CARRÉ. *Improvement in apparatus for economizing fuel.*

Claims the combination of a tilting grate and chute with a water pipe, arranged above the receptacle into which the coke is discharged.

225,296—March 9, 1880. WILLIAM A. MILES. *Charcoal kiln.*

Claims a chute having weighted doors arranged one above the other in a vertical plane.

380,427—July 17, 1888. DAVID EVANS AND ALBERT WILLIAM ADAMS. *Portable bottom coke oven.*

Claims in a coke oven having a pit below the level of its base or floor, the combination, with a movable bottom having a central opening, of a chain passing through said opening and through the eye of the oven, a portable crab above the oven mounted on rails, a spider or frame below the floor, and a car or truck mounted on tracks within said pit.

427,307—May 6, 1890. DAVID EVANS AND ALBERT WILLIAM ADAMS. *Portable bottom for coke ovens.*

Claims in a coking oven, the combination, with the piston of a hydraulic ram provided with a head having an upwardly extending conical projection, of a concave bottom provided with a central conical aperture adapted to receive the projection of the piston to support and center the bottom on the piston, and also to serve as a means for allowing the water thrown upon the coke to cool it after the bottom has been removed from the oven to flow off and leave the bottom clean and dry.

469,817—March 1, 1892. HUGH KENNEDY. *Coke oven.*

Claims in apparatus for coking coal, the combination of a stationary hearth on which the charge to be coked rests, an oven open at the bottom and set over said hearth with its sides extending to about the level thereof, and means for moving the oven laterally on the hearth, whereby the coked charge is dragged by the oven and removed from the hearth, said apparatus having a dumping place or drop in the path of motion of the oven.

499,565—June 13, 1893. GEORGE W. NIXON. *Coke oven.*

Claims the combination, with two sets of rails, arranged at an angle to each other, the lower rails being curved at their lower ends, of the traveling coke oven, having a base portion which travels on said lower rails, and a dome, or top portion, which is hinged to the rear edge of said base and provided with means for engaging with the upper rails, whereby the contents of the oven may be automatically dumped.

561,923—June 9, 1896. NORTON B. TAYLOR AND JOHN C. DIAS. *Coke oven.*

Claims a coke oven provided with a vertically movable bottom, comprising the metallic plate and noncombustible layer adjacent to the plate, the upper edges of the plate being flanged and extended inward over the noncombustible layer, and brick or tiling resting upon said layer and anchored to the plate, combined with a combined stop and scraper for said bottom.

728,953—May 26, 1903. GEORGE M. MILLER. *Coke oven.*

Claims the combination with a coke oven and an inclined floor therein, of an aperture in the floor, a frame, in the aperture, a slide plate working in the frame, and a chute underneath the frame and integral therewith, said frame and chute being made of heat-retaining material.

757,469—April 19, 1904. ANDREW C. KLOMAN. *Retort coke oven.*

Claims in a retort coke oven, a horizontal bottom, composed of pivotally connected sections, and means for elevating the pivoted portion of the same, whereby a fulcrum is formed for breaking apart the cake of coke and inclined beds are provided for the separated parts of the cake; and also, in a retort coke oven, a series of parallel ovens, walls common to each two adjoining ovens, a series of uptake and downtake flues in each wall associated respectively with said ovens, an offtake flue common to each series of uptake and downtake flues, and a main offtake flue common to the other offtake flues.

757,599—April 19, 1904. WILLIAM M. SCOTT. *Retort coke oven.*

Claims in a retort coke oven plant, a battery of coke ovens having pivotally mounted bottoms, a car arranged to travel beneath the said bottoms, a beam on the car, means mounted on the car and adapted to be operatively connected to any selected bottom for swinging the same on its pivotal mounting, and means cooperating with said beam for sustaining the reaction of said first-named means while operating the said bottoms.

Subclass 8.—Coke Processes.

93,629—August 10, 1869. WILLIAM J. LYND. *Improved process of preparing coke from Colorado and other coals.*

This is accomplished by coking the coal in ovens or kilns so arranged that when all the coal is in a state of combustion the draughts can be closed and the process is hastened and improved by the introduction of carbureted hydrogen gas or vapor from oil, coal tar, or other hydrocarbons.

98,606—January 4, 1870. WILLIAM JOHN LYND. *Improved process of preparing coal for smelting ores.*

The inventor places a mixture of five-sixths of coal and one-sixth of quicksilver in a furnace, thoroughly ignites, and then closes the furnace, or he makes briquettes of powdered coal and pine tar or other hydrocarbon and cokes them in a retort.

117,714—August 1, 1871. WALTER McPHEETERS AND CHARLES PEARCE. *Improvement in the manufacture of coke.*

This invention relates to improvements in ovens and a new process for making coke of slack bituminous coal, and consists in an oven composed of four vertical side brick or stone walls, traversed between said walls in both directions by V-shaped flues, formed of planks or slabs of wood, whereon the slack coal is packed as high as the walls will admit, around numerous small pieces of wood set endwise upon the flues, to form vertical passages by being drawn out after the slack is packed. The fire is set in each end of the largest flue, it is allowed to burn a sufficient time to expel the sulphur, and then put out by flooding. After the fire is started, should the slack become heated unevenly, the heat may be reduced by covering such overheated portion with earth or clay, which is removed when an even temperature throughout the oven is attained; or it may be sufficient to drop balls of mud over the vertical flues in the overheated portion, thus shutting off the draft and causing the heat to be evenly diffused throughout the slack.

136,592—March 11, 1873. HENRY ENGELMANN. *Improvement in processes for making coke from lignites. (Reissued July 15, 1873, No. 5,486.)*

The object of this invention is to provide a process of effectually coking brown coal, lignite, and other coal-like material incapable of being coked in the usual operation of an ordinary coking oven or retort, and consists in mixing with the lignite or other refractory material to be coked coal tar or certain varieties of bituminous coal or asphaltum or analogous substance and subjecting the material thus prepared to an initial and sustained heat above a cherry-red, laterally applied, sufficient not only to volatilize the hydrocarbons and eliminate the volatile matter contained in the mass, but also to decompose the aforesaid hydrocarbons into gases that may be conducted away and carbonaceous matter, that, being distributed through the mass, serves to cement the fragments of lignites or equivalent material together to form a compact product capable of use in the same manner as coke made wholly from "coking" or "caking" coal, this result being in contradistinction to that shown in the fragmentary and comparatively uncoked product obtained by subjecting lignite or like substance to the action of the coking apparatus hitherto in use. The invention also includes compacting the charge during or after its introduction to the coking furnace by subjecting it to pressure, as by compressing rollers, whereby the relative solidity of the mass and its integrity when used or applied for fuel purposes are materially enhanced; and,

Claims the process of coking brown coal, lignite, and analogous coal-like material incapable of effective coking by the usual practice with ordinary coking ovens by mingling the same with coal tar, asphaltum, or analogous substances, or with bituminous coking coal, or with coal tar and coking coal together, and subjecting the whole to an initial and sustained heat above a "cherry-red," so termed, and applied laterally throughout the mass.

150,872—May 12, 1874. WILLIAM J. LYND. *Improvement in coking fossil coals or lignites.*

Claims the process of treating fossil coals, as designated, by reducing the coal to a finely divided or powdered state, and then subjecting the same, whether mixed or not with a powdered or finely divided hydrogenous coal, to the coking operation.

150,873—May 12, 1874. WILLIAM J. LYND. *Improvement in coking fossil coals or lignites.*

Claims the mode of coking coals commonly known as lignites by coking the mass from the bottom upward and carrying off the gases in the opposite direction, the same being effected by the admission of air from above in small quantity at first, and the gradual diminution and final cutting off of said air supply as the coking proceeds and before it is terminated, the coking of the upper part of the mass being effected by radiation from the lower ignited portion.

The combination, with the charge chamber and the chimneys communicating therewith at or near the level of the floor or hearth, of one or more air-supply pipes or apertures, located in the top or arch of the oven, and communicating with said chamber.

The air flues beneath the oven floor or hearth for conveying air to the interior of the charge-chamber.

175,744—April 4, 1876. WILLIAM PENROSE AND WILLIAM F. RICHARDS. *Improvement in processes of making coke.*

The invention consists in the mixing or incorporating of anthracite or stone coal, or free burning steam coal, or coal known as Staffordshire slack, or other noncoking coals, with bituminous coal, or any other coal capable of making coke, together with pitch or tar, or with any form of tar or bitumen mineral oils containing bitumen, petroleum, or any of the waste products of petroleum, such coal or coals, pitch, tar, or other bituminous matters being ground and mixed together, and the mixture thus produced placed in any well-known form of oven or retort commonly used for coking, and the surface then covered with a layer of bituminous coal or other bituminous matter.

221,257—November 4, 1879. LEVI STEVENS. *Improvement in processes and apparatus for utilizing in furnaces the gases from coking coal.*

Claims the method of utilizing the gases arising from coking coal for fuel in furnaces, which consists in conveying said gases from the cells or chambers wherein the coking is in progress into a chamber adjacent to the furnace, then driving them with great force into the interior of the furnace, and there causing them to encounter a current of atmospheric air, whereby they burst spontaneously into flame, and develop great heat, susceptible of application to drying the coal and to other purposes, and the apparatus by which this is accomplished.

235,945—October 2, 1883. LAWRENCE H. ARMOUR. *Method of and apparatus for the treatment of spoil heaps of collieries.*

Claims the mode of treating the spoil heaps of collieries, peat bogs, and similar materials for the recovery of the volatile products therefrom, and for other purposes, consisting in closing the surfaces of the heaps practically air tight, and then withdrawing the gases arising from combustion by exhaustion and condensing the exhausted gases.

288,716—November 20, 1883. JEAN A. MATHIEU. *Process of manufacturing charcoal.*

Claims the process of removing deleterious substances from charcoal and rendering it more dense, which consists in washing the vapor of a distilling charge of wood, as described, and subsequently forcing the gases remaining uncondensed upon a charge of heated charcoal.

307,050—October 21, 1884. JOHN JAMESON. *Manufacture of coke.*

Claims in the manufacture of coke according to the ordinary process of igniting the charge at the top and burning gradually downward, the combination, with an oven provided with openings for giving ingress to the air and egress to the products of combustion at the upper part of said oven, of the outlet and exhaust for withdrawing from the lower part, and practically closed to the admission of air at the lower part, of the oven, the gases and vapors generated in or distilled from the coal below that in combustion, the purifiers, condensers, or scrubbers for treating said gases or vapors to recover therefrom materials such as oil, ammonia, and the like, and the pipes and connections for introducing at an advanced stage in the coking a regulated supply of the purified hydrocarbon gases or vapors at the bottom of the charge.

318,497—May 26, 1885. HENRY M. PIERCE. *Process of manufacturing coke.*

Claims, in the art of manufacturing coke, the method of conducting the furnace operation and increasing its yield, which consists in partially filling the oven with an initial charge and coking the same by downward progression; then, while such charge remains stationary within the oven, and near the end of the said coking operation, filling the oven to a further height by an additional charge, thereby retarding the coking of the initial charge, coking the second charge, and proceeding in like manner, the coking going on progressively until the oven is filled.

320,637—June 23, 1885. ARTHUR MARSHALL CHAMBERS AND THOMAS SMITH. *Method of coking coal.*

Claims the method of coking consisting in introducing an upwardly or horizontally directed current of hot air alone to the interior of the upper part of the oven and drawing the products of combustion down through the coal, the oven being without other inlet than said hot-air pipe during said operation, and the direction of the jet or current of air away from the coal, insuring uniform pressure on the latter and preventing it from being burned away or injured.

330,731—November 17, 1885. HENRY M. PIERCE. *Process of manufacturing coke.*

Claims, as an improvement in the art of manufacturing coke, the method of conducting the furnace operation which consists in heating the charge by radiation until inflammable gases are given off, then leading said gases beneath the floor of the coking chamber and burning them therein, thereby coking the under layers of the charge by radiated heat, and finally shutting off the flow of gases to the under combustion chamber and burning them in the top of the kiln, thereby coking the top layers of the charge by direct heat.

352,613—December 15, 1885. ISAAC M. KELLEY. *Manufacture of coke.*

This invention relates to a new and improved process of preparing coal for the manufacture of coke, and to apparatus therefor; and it consists in first separating the slack from the coal and at the same time washing it by jets of water, after which the slack and fine coal are ground to the required size and saturated, coated, or mingled with water, hydrocarbon oils, or other hydrogenous matter during the grinding operation, to supply a sufficient amount of hydrogen or carbon to facilitate the coking of the coal in coke ovens.

379,960—March 27, 1888. CHARLES H. LAND. *Manufacture of refractory carbon.*

Claims the process of producing a refractory carbon, consisting in subjecting carbonaceous matter in an open muffle located in a furnace to the products of combustion under pressure, whereby a counter resistance is offered to expel oxygen from the muffle, prevent ignition of said matter, and drive off determined elements therefrom.

388,542—March 23, 1886. JAMES J. McTIGHE. *Manufacture of hard carbon.*

This invention relates to the manufacture from the so-called 'natural gas" obtained in large quantities in certain parts of this country, and chiefly utilized at present for consumption in furnaces in various industries, of a dense hard carbon or coke, which in chemical constitution, in physical structure and characteristics, in appearance of surface and fracture, and in fitness for certain industrial uses differs essentially from any and all other forms or varieties of carbon known, and is readily distinguishable therefrom. This product is eminently useful for metallurgical purposes, and, in fact, wherever hardness, purity, fine texture, and uniform density are desired. It has, moreover, properties that render it particularly suitable for use in the manufacture of carbon pencils or electrodes for electric lights. The mode of treatment consists, briefly, in taking natural gas and decomposing it by heat, and precipitating the nascent molecules of carbon into a solid agglomerate.

421,299—February 11, 1890. HUGO MÜLLER. *Art of manufacturing coke.*

Claims as an improvement in the art of manufacturing coke from anthracite coal dust, the process which consists in aggregating the coal dust into boulets, then piling the boulets up in an oven or furnace, leaving continuous air channels from the bottom of the pile to its top, then passing through these channels a current of highly heated or ignited gases free from oxygen, and finally withdrawing the ready-formed coke from beneath while fresh lumps are fed in from above.

472,621—April 12, 1892. FREDERICK JOSIAH JONES. *Process of making coke.*

Claims in the process of making coke and obtaining by-products, the improvement which consists in cooling and washing the mixed gases resulting from the coking operation, collecting the condensable constituents, passing the cooled and washed gases through a purifier, then mixing them with fresh gas-producer gases generated from coke and with air, and finally passing the gases resulting from the combustion of the purified and reheated gaseous mixture through a fresh or partially coked charge.

485,904—November 8, 1892. JAMES C. ANDERSON. *Method of manufacturing or burning coke.*

Claims the process and method of coking coal, which consists in loading the coal upon a series of cars, igniting the coal upon the initial end of the train in any well-known manner, then passing the loaded cars consecutively through a tunnel way, utilizing the heat from the successively burning loads to heat the tunnel way and ignite and coke the charges of coal on the succeeding cars, and finally passing the cars out of the tunnel way at the opposite end to that in which they enter, thus constituting a continuous and progressive method and avoiding frequent handlings.

486,100—November 15, 1892. JAMES J. FRONHEISER AND CHARLES S. PRICE. *Manufacture of coke.*

Claims the process of manufacturing hard coke, which consists in pulverizing soft coal, mixing therewith a suitable hardening substance, charging the same into ovens, and heating them, and as a new article of manufacture, coke hardened by combining with it caustic lime or other suitable solid hardening substance in the process of its manufacture in such a manner that the proportion of its cell space to its cell walls is diminished, giving to it greater density and firmness.

511,334—December 26, 1893. GEORGE C. HEWETT. *Process of making coke.*

Claims the process of making coke, which consists in first heating comminuted coal at a low temperature under pressure greater than twenty-four inches of water, and then subjecting the thus prepared coal to a higher temperature and drawing off the volatile matters as in the ordinary coking operation.

609,150—August 16, 1898. JOHN THOMAS KEY. *Process of and apparatus for manufacturing coke.*

Claims the process of producing coke, which consists in igniting a charge of smudge at its top surface and introducing a supply of air above the same, producing a downward draft through the charge and thereby drawing the products of combustion through the same until the volatile constituents of the coal have been driven off, and then shutting off said downward draft and forcing steam in beneath the coke and up entirely through the same in the opposite direction to the original downward draft, in such quantity that the coke is thereby quenched and the remaining sulphurous fumes driven out thereof, and a coke oven comprising an oven proper having a false bottom consisting of three layers of bricks, pipes arranged to draw the products of combustion downwardly through the said false bottom, said pipes being connected with suitable exhausting and condensing apparatus, pipes extending around the circumference of the false bottom, adjacent to the middle layer thereof and provided with a plurality of openings, these latter pipes being connected with a steam supply, and pipes for the admission of air connected with a plurality of holes extending around the oven above the level of its charge.

613,980—November 8, 1898. EDWARD M. EIDHERR. *Process of eliminating impurities from coal, etc.*

Claims the process for the elimination of impurities from coal and ores during the coking or roasting process, consisting of the introducing into contact with the raw material by the aid of superheated steam, a quantity of glycerin and hydrochloric acid, and later introducing a quantity of glycerin and nitric acid, by the aid of superheated steam, and then subjecting the finished product to the action of the superheated steam.

637,595—June 27, 1899. FREDERIC W. C. SCHNIEWIND. *Coke oven and method of operating same.*

This invention relates to the construction and mode of operation of closed, externally heated coke ovens, having for its purpose the separate collection of the gases of varying richness and value given off at different stages of the coking operation, the drawing off of the gases at different stages of the coking by sucking or exhausting devices working at different pressures, the quenching of the coke while still in the oven and with utilization of its heat for the manufacture of water gas, and the carbureting of that portion of the water gas which is on generation of sufficient heat to crack hydrocarbon oils. And it consists in drawing off the gases generated in the oven at different stages of the coking operation through different gas mains and by means of exhausting devices working at different pressures, whereby the pressure in the ovens may be maintained approximately constant and approximately equal to the pressure in the surrounding heating flues. In this way it will be obvious that not only will the poor and rich gases be collected separately, but the loss of oven gas or its admixture with heating flue gas practically prevented.

637,955—November 21, 1899. JOSEPH HEMINGWAY. *Process of making coke.*

Claims the process of coking coal, which consists in confining the coal in an oven, firing the coal, then introducing into the oven, above the coal, an extraneously heated deoxygenized blast of a temperature, before its introduction, greater than that usually employed in the coking operation, to increase the heat in the oven above the temperature produced by the combustion therein of the gases generated from the coal and to accelerate the generation of such gases, and then permitting the deoxygenized blast and that portion of the evolved gases not converted into fixed carbon to escape through an opening at the top of the oven.

641,591—January 16, 1900. CHARLES B. JACOBS. *Conservation of volatile products from beehive coke ovens.*

Claims the method of collecting the volatile products in the coking of coal in beehive ovens, which consists in laterally deflecting the volatile products from the charging hole of the beehive oven by means of suction applied laterally to such charging hole, such suction being insufficient to affect the natural draft of the oven, and communication with the outer air being maintained through such charging hole.

644,012—February 20, 1900. JOSEPH HEMINGWAY. *Process of distilling coal.*

Claims the method of heating a part of a battery of coke ovens, which consists in utilizing the waste heat of one-half of said ovens, and also the heat obtained from the combustion of the volatile products of said half of said ovens, to heat and force air into the other half of said ovens.

680,780—August 20, 1901. WILLIAM JOHN KNOX. *Process of manufacturing coke.*

The general plan of the invention is to pass the hydrocarbon vapors generated in the coke ovens through suitable stoves, in which more or less of the heat carried by the vapors is conserved or stored, thence through cooling devices—such, for instance, as a steam generator—thence into heating stoves, where the temperature is raised to the degree required for effectively acting upon the coal to reduce it to coke. These heated vapors are then passed into the coking ovens and usually across the top of the bed of coal or coke. This operation is continued until the stove which has been employed as the heat absorbing stove has absorbed and stored a predetermined amount of sensible heat, whereupon the direction of circulation is reversed and this stove is utilized as the heating stove and the former heating stove as the heat absorbing stove, and this operation of reversal is repeated continuously at suitable intervals as long as the temperature of the stoves is sufficiently high to conduct the coking operation.

680,788—August 20, 1901. WILLIAM JOHN KNOX. *Manufacture of coke.*

This invention provides a process of making coke for metallurgical purposes by introducing a heated gas into the interior of a coke oven above the body of fuel and liberating heat from the gas within the oven by direct radiation, by contact with the coal or coke and with the walls and arch of the oven, and then by radiation from the walls and arch of the oven. The coking action resembles in some respect what is known as the "beehive" process in supplying the heat from above and acting downward on a comparatively thin broad layer of coking coal, which is free to expand, and the oven may be of the same general form as the beehive oven or the Welsh or Thomas oven. It differs from the beehive process, however, in not supplying air for the combustion of the fuel within the oven, the doors or openings and the charging openings being completely closed during the process, the charge of coal being converted into coke by baking from above by the action of heat carried into the oven from the outside by the fluid carrier.

706,448—August 5, 1902. PAUL NAEF. *Process of making coke.*

This is a continuous process, and the inventor claims in a process for producing coke, passing a mass of finely divided carbonaceous material through a shaft or furnace, generating a gas under pressure and heating said gas and coking said carbonaceous material by injecting said heated gas under pressure into the mass as it passes through the furnace or shaft, at a point between and a considerable distance from the ends of the furnace or shaft through which said mass passes, whereby portions of the mass will be coked successively and the hot gas with by-products absorbed thereby will ascend through the uncoked portion of the mass and be permitted to pass from the upper end of the shaft or furnace.

725,904—April 21, 1903. JOHN F. WILCOX. *Process of manufacturing coke.*

Many objections have been raised to the use of coke made in retort or closed coke ovens for metallurgical purposes, based mainly on the presence of a greater or less amount of spongy, porous, friable coke. The inventor seeks to prevent the formation of this spongy, porous, friable coke by the process of manufacturing coke in retort ovens, consisting in forming outside the ovens the charges with a portion or portions of the same spaced apart, the spaced portion or portions extending from the top of the charges to a short distance from the bottom, entering the charges into the ovens, and heating the same.

731,943—June 23, 1903. JOHN A. POTTER. *Method of making coke and gas.*

This invention is for a continuous process of coke and gas making and there is claimed the method of making coke and gas, consisting in maintaining a vertical burden, intermittently feeding coal to the upper end and shearing off and removing coke from the lower end of said burden, drawing the lean and fuel gas from an intermediate point of the charge, and burning it around the intermediate and upper portion of the charge, and withdrawing the rich and illuminating gases from the upper end of the charge for further use.

744,667—November 17, 1903. BERNHARD ZWILLINGER. *Process of carbonizing.*

This invention relates to carbonizing wood, and there is claimed the carbonizing process which consists in mixing an excess of air with combustible gas, heating the mixture under the exclusion of further atmospheric air in a confined space bringing the resultant gases into contact with material to be carbonized under the exclusion of atmospheric air so as to carbonize the material partly by the heat of the gases, partly by the combustion of the hot combustible gases introduced and partly by the combustion of the gases given off from the material being carbonized.

755,155—March 22, 1904. EDWIN A. MOORE. *Process of quenching and bleaching coke.*

Claims the process of extinguishing and bleaching coke, which consists in transferring hot coke from an oven into a receptacle from which atmospheric air is excluded, deluging the coke with water and discharging the excess of water as rapidly as it is supplied, and then subjecting the coke to steam generated in the receptacle by the heat in and the water on the coke.

763,369—June 28, 1904. MICHAEL R. CONLEY. *Process of making coke.*

Claims the process of making coke, which consists in inclosing the coal in an essentially air-tight oven of nonconducting material and raising the inner wall of the oven by means of electrical resistances included in the wall to a temperature higher than that obtained in the ordinary coke oven.

769,241—September 6, 1904. CHARLES F. SPAULDING. *Process of coking coal.*

This invention relates to beehive ovens, and the inventor claims the process of coking coal, which consists in confining the coal in an oven, firing the coal, and then forcing into the oven above the coal a blast of combined air and oxygen.

788,558—May 2, 1905. ALBERT D. SHREWSBURY. *Process of producing compressed coke.*

The object of this invention is to provide a practically continuous and simple process for producing compressed nonporous blocks or briquets of coke designed to be used as fuel, since compressed coke has many advantages over ordinary coke and for some purposes is superior to anthracite coal. It is compact, easily handled, occupies but little space for shipping, is free from sulfurous and other noxious gases, it burns freely, and is almost entirely consumed, leaving but little clinker or ash. In carrying out the process the coke is taken from the coke oven at the time when it has reached a plastic or agglutinate state and compressed into blocks of the desired size and shape. These blocks or briquets may be produced as a by-product of a gas producing plant, or the product may be the result of a specially designed apparatus in which the gas may be regarded as a secondary consideration. The coke is dumped into the compressor as quickly as possible to avoid the ignition and consequent combustion of the same.

Subclass 9.—Coke Ovens—Retort Ovens.

19,575—March 9, 1858. DANIEL C. KNAB. *Improvement in the manufacture of illuminating gas.*

This invention consists principally in the peculiar consideration and operation of carbonizing furnaces, and what distinguishes these furnaces from all others heretofore in use is that while carbonizing coal on a large scale the inventor obtains besides the coke all other accessory products of the distillation, such as tar, ammoniacal liquor, and gas, and he provides for the reworking of these secondary products so as to obtain benzol, creosote, sulphate of ammonia, and a variety of other products.

87,412—January 13, 1869. WILLIAM GEORGE VALENTIN. *Improvement in coking coal and generating gases.*

Claims coking coal in close chambers or retorts heated externally by the combustion of gases generated from similar previous coking operations, and applied in the manner set forth, and the use of vertical close chambers or retorts, in combination with external flues or heating channels supplied with combustible gases and air from burners. The inventor quenches his coke with hydrochloric acid gas or dilute hydrochloric acid which it is alleged removes part of the sulphur from the coke.

65,820—June 18, 1867. FREDERIC J. F. LAUMONIER. *Improved circular coke oven.*

Claims a circular coke oven, composed of any suitable number of radial compartments converging towards a central chimney, in combination with flues for conducting the products of combustion from the said compartments to the central chimney, the combination, with the radial compartments provided with openings in their top, of a circular railway passing over the said openings, and a water conduit or pipe encircling the oven.

103,507—May 24, 1870. LEWIS SCHANTL. *Improvement in coke ovens.*

Claims the combination and arrangement in pairs of two or more coke ovens, in such a manner that the burning gases given off by the coal in each may, by means of vertical and side flues, be made to pass around the sides and bottom of both ovens, for the purpose of more evenly and effectually distributing the heat to all parts of each oven, and the construction of the walls of U-shaped blocks, which at the same time form the vertical flues.

105,413—July 19, 1870. LEONARD FORBES BECKWITH AND ARTHUR BECKWITH. *Improvement in coke ovens.*

This invention consists in a novel arrangement of vertical and horizontal flues, chambers, and communications, whereby the gases evolved in coking are utilized in a most advantageous manner, and includes a tongue construction of fire bricks applied to form the flues through which the gases are circulated, and serving to brace the walls of the oven. The invention is applicable to coking various kinds of coal, either separately or mixed, with or without a cementing substance—such, for instance, as coal tar or asphalt.

119,092—September 19, 1871. THEODORE G. MEIER. *Improvement in coke ovens.*

The improvements relate: To such a novel arrangement of vertical and horizontal flues that each oven gives as well as receives heat, and whereby the gases are utilized and the generated heat is equally distributed to all parts of the oven; to a peculiarly constructed right or left trough-shaped tile, forming the upper and lower inlet and outlet connections with vertical and horizontal flues; in forming a skew-back tile with two horizontal holes and one diagonal hole or flue, whereby said tile is also made right or left in combination with trough-shaped tile; in arranging, in combination with vertical and horizontal flues, a system of pipes to aid combustion of gases by the introduction of cold or hot air or steam; the arrangement and construction of all said parts being such that every oven can be operated separately or independent of adjoining ovens.

141,778—August 12, 1873. HENRY ENGELMANN. *Improvement in coking furnaces.*

Claims the combination, with narrow and high ovens, of the vertical heating flues, provided in the walls between these ovens, constituting, in fact, as many different heating furnaces, and a valve or equivalent means of throttling or stopping the outflow of gases from the material subjected to coking, whereby the retention of the gases long enough to secure the most efficient deposition of carbon therefrom is provided for.

141,779—August 12, 1873. HENRY ENGELMANN. *Improvement in coking furnaces.*

This invention consists in the combination of vertical flues arranged in the side walls of coking ovens, of peculiar height, with gas or flame conduits, diminishing in transverse area as the number of flues to be supplied diminishes, in such manner that combustible gases to be burned in the flues themselves, or flame and hot products of combustion from the burning of such gases in the conduits, or flame and hot products of combustion from a furnace connecting with the conduits, will (one or the other, as the case may be) be uniformly distributed throughout whole series of flues to uniformly heat the ovens throughout their length. The invention also comprises certain novel means of supplying the requisite quantity of air to the burning fuel, of equalizing the draft of the heating flues, and of facilitating the removal of the coked product from the oven.

169,756—November 9, 1875. HENRY AITKEN. *Improvement in coke ovens.*

The object of this invention is a coking oven in which air, after being thoroughly heated by passing through heated channels, is directed among the gases arising from coke arranged upon a stationary or movable bottom. The claims cover special combinations of oven, passages, heating pipes, flues, and tuyeres, with mechanism for operating the movable bottom.

171,871—December 21, 1875. EMIL S. GOBIET. *Improvement in coke ovens.*

This invention consists in combining with a coke oven a series of side flues, bottom flues, and top flues, the side flues being made to communicate with the interior of the oven in such a manner that the heated gases which escape from the oven envelop said oven from all sides, and thereby a uniform heat is produced, and the formation of coke is materially facilitated.

176,319—April 18, 1876. SEBASTIAN STUTZ. *Improvement in coke ovens.*

The invention consists in the particular construction and arrangement of a coke oven, called independent—that is, which can be erected and worked either separately or in connection with any desired number, and in which the openings and chambers are so combined that part of the produced gases resulting from the coking heats the oven itself, whereas the remaining gases, usually wasted, may be collected in a reservoir, and either admitted to a boiler or puddling furnaces for heating them; or they may be exhausted from the reservoir, and cleaned for illuminating purposes; or they may be let into the open air through a chimney and wasted.

180,010—July 18, 1876. SAMUEL DIESCHER. *Improvement in coke ovens.*

This invention relates to an improvement in coke ovens; and it consists in the construction and arrangement of gas and air flues for the purpose of cooling by the latter the foundation and lower portions of the brickwork of the ovens, and also for using the air, after becoming heated and intermixed with the gas escaping from the coal during the process of coking, to obtain an intense heat by a thorough combustion of the gas.

208,930—October 15, 1878. WILLIAM H. ROSEWARNE. *Improvement in coke ovens.*

Heretofore, in the process of coke making, a considerable amount of fuel has been consumed in igniting the charge of coal, and after ignition a still greater waste was occasioned by allowing the burning gases from the charge to pass off without doing any useful work. To prevent this loss, and to also shorten the time of the process, the inventor constructs the coke ovens in pairs, so that they may act conjointly, and in the dividing wall, near the top, he arranges, in a horizontal line, a number of connecting flues, capable of being closed or opened by a horizontal damper, so as to allow the burning gases from the operating oven to be conducted over for the purpose of igniting the fresh charge in the other oven; and in order to insure rapid combustion he provides a series of flues, so arranged as to conduct the gases from the ignited charge under the hearths, said hearths being sufficiently elevated and mounted on rollers in order to facilitate the charging and discharging of the ovens. Walled spaces beneath the hearth, and formed by it, constitute subhearth flues, which communicate by other similarly formed flues with the stack.

278,822—March 13, 1883. RICHARD DE SOLDENHOFF. *Coke oven.*

This invention relates to certain improvements upon the well-known Coppée coke ovens, and consists, first, in increasing the heating surfaces in the oven to their maximum. The increase of heating surfaces is attained by giving to the oven the shape or form of a rectangle, in which the numerical value of its area is not more than half of the numerical value of its periphery, and second, in the means of restoring the heat to the ovens, which would be otherwise lost, and third, the arrangement of the cross flues outside the oven.

279,069—June 5, 1883. FRITZ LÜRMANN. *Apparatus for the continuous distillation, sublimation, or roasting of solid materials.*

Claims, in a distilling kiln or coking oven, the working-oven having its bottom, side, and top walls formed of thin fire brick placed flat-wise in the walls, braced or supported at their joints all round the oven by right-angled walls, which also form flues bounded in one direction by the thin walls of the oven floor and sides, and the top chambers, in combination with a charging apparatus arranged to force solid materials through said oven.

281,046—July 10, 1883. HERMAN FRASCH. *Furnace for the manufacture of carbon.*

This invention relates to an improvement in furnaces for the manufacture of carbon for electric light carbons and other purposes; and

Claims a furnace for the manufacture of carbon, constructed with a flat floor or hearth composed of tiling with packed joints and capable of retaining a liquid or semiliquid substance thereon, flues extending beneath the entire floor, discharging doors located on a level with the hearth or floor, and a charging door located above the level of the hearth or floor.

282,064—July 31, 1883. FREDERICH C. EBERLEY AND RUDOLPH RICHTER. *Coke oven and kiln.*

This invention relates to an improved oven in which coal is reduced to coke and the heat utilized. After the first ignition, and when the ovens and inclosing masonry have become heated up, the coal in the ovens is fired by the heat of the masonry. The smoke arising finds an outlet through apertures made in the arch of the ovens into channels suitably located. The gas arising and passing out through side apertures comes in contact with air from the exterior introduced through suitable channels, and is ignited, thereby thoroughly heating the masonry of the ovens. The products of combustion thus produced ascend through vertical flues into a main channel or flue, which conveys them to the kilns in which the burning is to be done. These kilns are suitably located between the series of coke ovens, so that the heat given off by the surrounding masonry of the coke ovens, as well as the products of combustion above described, is thus utilized. The arrangement of the flues conveying the ignited gases to the kilns is such that they may be taken to one kiln and then discharged into the smokestack, or if they are not spent, may be carried on to another kiln.

282,604—August 7, 1883. JOHN F. BENNETT. *Apparatus for the manufacture of bituminous coal coke.*

Claims a combination of furnace, flat-arched-roofed ovens, passages, flues, boilers, fan, valve, gas holder, pipes, hood, cars, track. He cools his coke by steam.

287,332—October 23, 1883. LOUIS SEMET. *Coke oven.*

The improved kilns or ovens consist of a series of massive vertical walls connected together at their upper ends by arches or vaults which support the superstructure of brickwork, and with the walls form a series of coking or distilling chambers. Within these chambers, and on each side of the vertical walls, are placed large hollow bricks of fire clay, the sides of which bricks are made thin, so as to allow of the heat passing easily through them. The said hollow bricks are placed either vertically side by side or horizontally one above the other, and through the said hollow bricks the gases and products of combustion are caused to circulate. The result of the above described combination of a massive wall covered on each side with series of hollow fire clay bricks is a sort of threefold wall extending throughout the entire height of the chamber, wherein the coal to be coked or distilled is to be placed. From suitable furnaces the flames and products of combustion pass under the soles of the chambers, and at the rear end of the said chambers they separate into two currents, which pass through the series of hollow bricks, whether disposed horizontally or vertically, the velocity of the said currents being regulated by suitable dampers. If required, a second inlet for gases and air may be arranged by means of branch flues placed underneath the gas flues, and vertical ducts may be formed in the massive walls, to conduct heated air to the parts where the gases enter. When arranged side by side, the hollow bricks form vertical flues, and when placed one above the other the hollow bricks form horizontal flues, and in both cases they constitute hollow sides of the central massive wall. Longitudinally the walls are consolidated by means of suitable tie rods, and the bricks are prevented from sliding transversely by the bricks forming the soles and arches of the kilns or ovens. The said bricks may also be connected together by grooves and tongue pieces throughout their length.

287,905—November 6, 1883. FRANÇOIS CARVES. *Coke oven.*

Claims, in a closed coke oven heated by external firing, the combination of coking chambers, partition walls, horizontal zigzag flues in the partition walls, communicating at their upper ends with flues beneath the bed of the oven leading from the firing place, and at their lower ends with the chimney, so that the hot combustion gases shall pass to the top of the zigzag flue and travel downward therein before escaping to the chimney.

288,874—November 20, 1883. GEORGES SEIBEL. *Coke oven.*

This invention relates to the manufacture of coke from coal, especially from bituminous coal, and is based on the fact that the hydrocarbon gases produced by the distillation of coal, and passing at a high temperature through a mass of coal which is being converted into coke, yield a portion of their carbon to the spongy material through which they are passing, and that the quantity of carbon thus given off increases with the thickness of the coal stratum through which the said gases are filtered, and consists of a peculiar combination of flues and tuyeres in a coke oven, which dispenses entirely with a grate, and is heated by the gas arising from the distillation of the coal.

291,422—January 1, 1884. HEINRICH STIER. *Coke oven.*

Claims the combination, with a generator, and coke shafts, of channels, arranged in front of and surrounding said generator and coke shafts, said channels being composed of layers of perforated stone, or its described equivalent, for heating the gas or air used for combustion; and the combination of the movable slides or registers with the entrance and exit channels of the coke chambers, said slides being arranged substantially as shown, whereby, by their proper adjustment, each coke chamber may be utilized as such, or by closing the passage for the outflowing products of distillation and connecting the coke chamber with the main gas channel, each coke chamber may be utilized as a generator.

293,023—February 5, 1884. ARTHUR RICHARD BALDWIN HILTAWSKI. *Coking furnace.*

The invention consists in a coking furnace constructed with a series of coking chambers for receiving the coal to be coked, between which coking chambers gas chambers are arranged, into which gas is passed from the coking chambers, the said gas chambers being provided in their bottoms with openings leading to transverse channels connecting a series of longitudinal channels below the gas chambers, so that the gases will circulate until exhausted, and then pass off through a suitable channel leading to the smokestack.

302,171—July 15, 1884. HEINRICH STIER. *Coke oven.*

Channels or pipes are arranged in the upper part of the apparatus for utilizing the radiating heat, through which channels or pipes air and water are forced, and in which they become heated, the water being turned into steam. The air may be forced in under pressure. The steam is serviceable for transformation into water gas, which transformation can be accomplished by forcing the steam, either alone or together with air, into the coke chamber. For this purpose the coke chambers may be provided with a pipe or other opening leading into said coke chamber. This construction of oven may thus be used for treating bituminous and carbonaceous substances for obtaining heating gases and products of distillation.

308,139—November 18, 1884. FRANÇOIS CARVES. *Coke oven.*

Claims, in combination with a range of coke ovens heated by external firing, one or more external horizontal smoke flues extending along the range of ovens with the firing places of which it or they communicate, and one or more air flues arranged alongside of the said smoke flues, through which air flues the air supply to the said firing places is made to pass, so as to take up the heat given off to the walls of the smoke flues by the combustion gases.

318,496—May 26, 1885. HENRY M. PIERCE. *Coke oven.*

Claims a coking oven having a coking chamber, a combustion chamber arranged immediately under the coking chamber so as to heat the same, and a central gas-exit flue which connects the upper part of the coking chamber with the combustion chamber, the floor of the coking chamber being inclined from the gas-exit flue to the discharge doors of the coking chamber.

330,732—November 17, 1885. HENRY M. PIERCE. *Furnace for the manufacture of coke.*

Claims a battery of coke ovens having each a closed coking chamber and basal combustion chamber, in combination with a receiving main extending along and common to all the ovens, valved branch pipes joining said main with each of the

closed chambers, a delivery main parallel to the receiving main, valved cross pipes connecting the two mains, and valved branch pipes connecting the delivery main with each of the combustion chambers.

338,605—March 23, 1886. JAMES J. McTIGHE. *Apparatus for producing hard carbon from hydrocarbon vapor.*

Claims an apparatus for producing coke from natural gas, comprising in combination a furnace structure, a vented retort set therein, a main supply gas pipe, a branch thereof communicating with said retort, and a second branch leading to said combustion chamber.

406,986—July 16, 1889. THEODOR BAUER. *Coke oven.*

Claims a coke oven having a series of radial retorts connected by ducts with a central gas conduit, an annular combustion chamber provided with air induction flues and surrounding said gas conduit, flues connecting the central conduit and the annular combustion chamber, and a central exit pipe within the gas conduit having its lower end connected with a series of gas outlet channels which are so arranged vertically between two series of horizontal air inlet channels that the air passing through said air inlet channels is heated by spent gases passing out of said vertical pipe.

407,879—July 30, 1889. ADAM WEBER. *Coke oven.*

Claims the combination of a coke chamber, a combustion chamber provided with a grate, each side wall of the combustion chamber having separate series of horizontal gas heating flues, gas supply pipes connecting with the front end of the lowermost gas heating flue, and lateral channels connecting the uppermost gas heating flues with the combustion chamber, and means for supplying air to the combustion chamber.

409,081—August 13, 1889. ADAM WEBER. *Coke furnace.*

Claims the combination of a coking chamber formed of blocks or tiles, a mantel surrounding the coking chamber, lateral brace blocks connecting the side walls of the coking chamber and mantel, and lateral plates connecting the upper corners of the coking chamber and mantel, said plates being provided with front and rear openings, and sliding dampers for regulating the size of said openings.

409,567—August 20, 1889. RICHARD DE SOLDENHOFF. *Apparatus for the manufacture of coke.*

Claims the combination, with two or more coke ovens and flues under said ovens, of an incinerating furnace situated between said ovens and consisting of two inclined chambers communicating at their upper ends, flues connecting the upper portions of said ovens with the lower ends of said inclined chambers, and flues under said inclined chambers connected with the upper ends thereof and with the flues under the ovens.

421,583—February 18, 1890. ISAAC N. KNAPP. *Coke oven.*

Claims in a stack of coke ovens, the combination of the ovens, combustion chambers situated below said ovens, chambers situated above said ovens, flues connecting the chambers below with the chambers above, a gas main connecting with the ovens, conduits arranged on each side of the stack connecting with the main and having independent stopcocks, a series of pipes leading from conduits to the chambers below, regenerators connected, respectively, with the chambers below by openings, chambers below and beside the grates connecting with the regenerators, an air chamber, a chamber connected with the stack, conduits leading from the said four chambers to a valve chamber, a four-way valve by which the air chamber can be connected with either of the regenerators and the stack with the other regenerator at will, and a steam pipe having branches extending into each oven and opening therein through numerous orifices.

436,883—September 23, 1890. CHARLES N. TRUMP. *Apparatus for making coke and gas.*

Claims the combination of a gas generator, a coke oven, a regenerator, a cooler, a scrubber, and gas connections extending from the generator through the regenerator, cooler, and scrubber, and back through the regenerator to the furnace of the coke oven.

445,804—January 27, 1891. EDWARD T. COX. *Apparatus for making coke.*

Claims a coking oven provided with a closed chamber with perforations in the bottom and adapted to receive the coal, a bottom channel leading to a receptacle for the liquid products below said bottom, a heating casing arranged within the chamber in position to be surrounded by the coal, and means for introducing a heating medium into the casing.

451,488—May 5, 1891. FREDERICK JOSIAH JONES. *Apparatus for making coke.*

Claims the apparatus for coking coal by the passage through it of the gases of combustion, such apparatus consisting in the combination of a gas producer, a central gas combustion chamber in communication with the producer and situated between duplicate sets of coking chambers, and of gas collecting chambers placed at the other sides of the coking chambers, the walls separating the coking chambers from the combustion chamber on the one hand and the collecting chamber on the other hand being perforated to give passage to the gases, the two coking chambers of each set having oppositely inclined floors, heating chambers beneath the floors, and inclined ledges or shoulders at the upper part of the side walls of the coking chambers.

455,684—July 7, 1891. WILHELM FRITSCH. *Coke oven.*

Claims the improvement in coke ovens, which consists in a plurality of vertical parallel coking chambers, a combustion chamber interposed between each two coking chambers, an air heating flue arranged immediately under the sole of the combustion chambers and provided with a plurality of air escape ports of different area opening into the combustion chamber at different points, a damper for the air port of greatest area, and flues for the escape of the products of combustion interposed between the air heating flues immediately under the sole of the coking chambers and in communication with the combustion chambers.

477,286—June 21, 1892. JOHN ARTHUR YEADON AND WILLIAM ADGIE. *Retort furnace.*

Claims a retort furnace, in combination with a retort revolubly mounted in the furnace, the interior of said retort being provided with stirrer blades tapering or diminishing in height toward the discharge end of the retort.

492,400—February 28, 1893. GUSTAV HOFFMANN. *Coke oven.*

Claims in combination ovens having the combustion chambers under the same, and shafts extending about them, canals at the top of said shafts, regenerators with air passages leading thereto, gas conduits leading from the ovens and ports connecting the same with the canals and the passages, leading directly from the regenerators to the canals and past the combustion chambers.

500,684—July 4, 1893. FRANZ WESTERMANN. *Regenerative coke oven.*

Claims in combination, two series of coking chambers with their independent combustion passages, pipes for supplying gas thereto, two regenerators arranged side by side and intermediate of the coking chambers and extending longitudinally from end to end of the series, a series of conduits extending from the regenerators, respectively, down between the separated passages, and having lateral branches connecting the conduits with the passages and the valves in the said lateral branches.

504,548—September 5, 1893. THEODOR BAUER AND GEORG MENDHEIM. *Coke and carbonizing oven.*

Claims the combination of a series of parallel carbonizing chambers, combustion chambers located near the tops of the carbonizing chambers and at the outer ends of the same, air heating apparatus, passages leading from the tops of the carbonizing chambers to the combustion chambers, passages leading downward from the combustion chambers near the outer ends of the carbonizing chambers, upward flues passing along the carbonizing chambers and flues placed in connection with said upward flues and conducting to the air heating apparatus; said air heating apparatus being provided with vertical downtakes for the waste gases connected at the bottom with the chimney, and also provided with air passages arranged to compel air and gas to travel in substantially opposite directions, inlets for atmospheric air connected to the bottoms of the air passages, and flues connecting the tops of the air passages with the combustion chambers.

510,448—December 12, 1893. MARTIN V. SMITH. *Oven for the manufacture of coke.*

Claims in combination with an outer wall, an interior oven within, a series of vertical flues between the wall and oven and encircling the latter, an annular gas flue arranged horizontally in the upper part of the outer wall and in connection with the vertical flues and a second annular horizontal flue for the air with passages therefrom to the vertical flues, gas and air supply pipes connecting with the flues, a draft stack leading from the base and passages from said vertical flues to said stack.

511,974—January 2, 1894. ARCHIBALD ROBERT STRACHAN. *Coke oven.*

Claims in a coking oven having a charging chute in its top and an exit flue communicating with said chute, also with diving flue and with a series of flues beneath the oven floor formed by the cruciform chamber inclosed by walls connected to the oven walls, said chamber being divided by a main partition connected to the oven wall adjacent the said diving flue and extending near the opposite side of the oven and also divided by a partition transverse to the main partition and terminating at each end near the oven wall, said flues beneath the floor communicating with an up-draft chimney flue, a part of said series of subfloor flues, next in the course of escaping products to the coking chamber, being situated adjacent to others more remote from said chamber to heat said more remote and relatively cooler flues by conduction through the intermediate walls and thereby quicken the draft therein.

513,257—January 23, 1894. THEODOR BAUER. *Coke oven.*

Claims in a coke oven plant, the combination of a series of horizontal retorts, combustion chambers located between the retorts at their outer ends and near the tops of the same, a series of vertical flame flues on the sides of the retorts, air heating apparatus located beneath the retorts, channels for leading cold air to and through the air heating apparatus, vertical hot air flues between the flame flues connected with the cold air channels, horizontal chambers between the combustion chambers, and communicating with the same and flues leading from the flame flues to and through the air heating apparatus and from the latter to the chimney.

516,184—March 13, 1894. FRANZ BRUNCK. *Coke oven.*

The object of this invention is to essentially increase the efficiency of the wall heating. In ovens having double separated wall heating channel systems in each partition wall, and while the upper horizontal connecting channels were, up to the present time, placed above the top of the oven chamber, these channels are by this inventor placed below the top on the sides.

537,872—April 23, 1895. CHARLES H. VANNIER. *Coke oven.*

Claims a coking oven having a dome-shaped top and flat bottom, a series of straight horizontal flues arranged beneath the bottom and communicating, with a common transverse flue, a series of straight vertical flues in the rear wall, each vertical flue having direct communication with two of said horizontal flues, the inclined flues leading from the tops of the vertical flues into the oven, and one or more inclined air-passages leading into each vertical flue.

551,115—December 10, 1895. NILS KARL HERMAN EKELUND. *Apparatus for manufacturing coal powder from peat, etc.*

Claims in a coking apparatus for manufacturing coal powder of peat, sawdust, and the like, the combination of a zigzag-shaped drying and coking conduit, provided with transport screws for moving the mass, a heating canal extending beneath and along said conduit, this canal communicating below with a fireplace; a compartment, forming a part of the conduit and situated at a distance from one end of the same, feeding rollers situated in the compartment, and a damper serving to regulate the feeding so as to maintain the compartment filled with the mass, whereby the conduit is divided into two divisions, viz, one upper division for the drying and one lower division for the coking.

568,074—September 22, 1896. FRANK L. SLOCUM. *Coke oven.*

Claims a longitudinally extending coke oven having heating flues in the side walls thereof and having the side walls between the coking chambers and flues formed of vertical slabs with horizontally and inwardly extending flanges above and below the flues, and horizontal tiles forming tile plates between the vertical slabs extending into the central wall beyond the slabs.

568,075—September 22, 1896. FRANK L. SLOCUM. *Coke oven.*

Claims a bank of coke ovens having longitudinally extending coking chambers, combustion and heating flues in the bottom and side walls thereof, and a series of longitudinally extending waste product flues and air heating flues alternating with each other and filling the space under the coke oven, a gas producer communicating with the combustion flue of the coke oven, the bottom air heating flues of said series leading to the gas producer, and the other air heating flues passing between the waste product flues and opening into the combustion flue under the coking chamber.

582,491—May 11, 1897. HUGO STINNES. *Coke furnace.*

Consists in building up the coking chamber with heating flues at the bottom and at the sides and in providing such air admitting and air heating flues that the best utilization of the heating gas is obtained and that the flues during the process may be controlled and inspected, and finally, that repairs in the most exposed parts of the interior of flues and distilling chamber may be made without disturbing the neighboring parts in the furnace and in the flues and without necessitating the pulling down of other parts of the furnace.

607,487—July 19, 1898. LOUIS J. HIRT. *Coking oven.*

Claims a coking oven comprising a retort, a series of substantially horizontal flues arranged one above the other on opposite sides of the retort and extended substantially the length of the retort to form a continuous passage for the heat from end to end of the retort, vertical flues communicating with said horizontal flues at the opposite ends of the same, substantially horizontal flues communicating with the end flues and extended below the sole of the retort toward its center, and regenerators connected to said sole-heating flues.

615,707—December 13, 1898. ALBERT HÜSSENER AND LOUIS HOLBECK AND JOSEPH KIRSCHFINK. *Horizontal coke oven.*

Claims in horizontal coke ovens for recovering by-products having partition walls between the coking chambers and a separate system of zigzag flues at either side of each of the said chambers, the combination of a duplex subsole flue having each of its members separately and independently communicating with one of the said lateral flue systems, each of these members being connected to one uptake of each side wall flue system and of a series of auxiliary air channels lying between the lowest waste heat flues in the lowest part of the foundation of the oven, extending with both ends through the front walls of the ovens—one end of these channels leading to the open air for the reception of cold air and the other end communicating with the pipes for leading the heated air to the gas supply—entering the heating flues for the purpose of combustion therewith.

624,173—May 2, 1899. ALBERT CAMPBELL. *Fuel.*

Claims an improved fuel, consisting of coke, the lumps or pieces of which have smooth external surfaces.

627,643—June 13, 1899. JOHN BOWING. *Process of and apparatus for coking.*

Claims the process of coking refractory coal, which consists in placing the coal in a finely divided and wet condition in a closed retort, raising the temperature rapidly until the coking temperature is reached, and maintaining the temperature of the coal without fluctuations until the coking is complete, and conducting the gases produced during the coking of the coal to the coal to be afterwards acted upon, to enrich it; and,

A coking oven provided with a vertical retort of metal, a muffle of nonheat-conducting material surrounding said retort for protecting the same, but separated therefrom by an intervening annular space, a circular flue surrounding said muffle and passages for conducting the products of combustion to the flue, the combined sectional area of said passages being equal to the sectional area of said flue, whereby fluctuations in the temperature of the retort and contents are prevented.

632,116—August 29, 1899. LOUIS J. HIRT. *Coking oven.*

Claims the combination with a coking oven provided with a series of retorts having a series of heating flues, of generators located on substantially the same level as the coking oven and provided with outlet pipes or flues extended on opposite sides of the coking oven and communicating with the heating flues, and gas supply pipes extended on opposite sides of the coking oven and communicating with said heating flues.

644,369—February 27, 1900. FREDERIC W. C. SCHNIEWIND. *Regenerative coke oven.*

Claims in combination with a bank of coke ovens having regenerators for preheating the air and to support combustion by the waste heat of the furnaces used for heating the ovens, a system of cooling flues situated in the masonry beneath the ovens and furnaces, a collecting fan for drawing air through said flues, and a discharge conduit from said fan connecting with the air-supply pipes leading to the regenerators.

649,450—May 15, 1900. GUSTAV HILGENSTOCK. *Coke oven.*

Claims in combination with a series of horizontal externally heated coke ovens arranged side by side and having heating flues arranged in their partition walls and discharging openings at their ends, a series of parallel tunnels, of size sufficient to permit the passage of a man, arranged beneath the ovens and heating flues and parallel with the ovens, gas conduits running through and accessibly situated in said tunnels and a series of burner pipes extending from different points along the length of each of said conduits into the heating flues.

649,483—May 15, 1900. OTTOMAR RUPPERT. *Externally heated coke oven.*

Claims in combination with a series of horizontal coke ovens arranged to receive heat through their walls and for the saving of by-products, two separate and relatively independent combustion chambers situated one above the other between the walls of adjacent ovens, separate air and gas supplies entering each combustion chamber and a common flue system also situated between the adjacent ovens connected with but not passing through the combustion chambers.

654,036—July 17, 1900. ROBERT E. LAUCK. *Retort furnace.*

Claims in a retort furnace, a retort having its front end projecting through the furnace wall, and comprising a casing having an inlet port near one end and an outlet port at the other, and provided with an internal comb, a perforated partition at the front end of the comb and furnace, a nonconductor of heat filling the casing forward of the partition, and a shaft journaled in the casing and extending through the partition and provided with a skeleton spiral conveyor, the teeth of which pass between those of the comb.

654,307—July 24, 1900. EVENCE COPPÉE. *Coke oven.*

The object of this invention is to provide an oven in which the gases may be introduced into the lower parts thereof and principally under the bottom of the oven chamber, so that the greatest heat may be produced in these lower parts and the heat in the upper parts will not be great enough to decompose the light oils which are evolved from the coal in the oven. It also aims to distribute the inlets for the gases and air, so as to have uniform heat in the middle and at the ends of the oven, and to provide means for dividing and controlling the draft in the flues of the oven and to separately regulate the draft of the gases and of the air introduced at the front and at the back of the oven into these flues, and the inventor claims a particular arrangement of chambers, openings, and flues.

658,893—August 28, 1900. JEANNOT W. KENEVEL. *Apparatus for treating coal and ores.*

Claims in an apparatus of the kind described, the combination of a horizontally arranged retort having means for charging and discharging the same, a combustion chamber beneath the retort, a substantially vertical flue communicating with the combustion chamber and arranged at the side of the retort for heating the same, an elongated horizontal flue located adjacent said retort and combustion chamber and communicating by means of a return flue with said vertical flue, a steam heating pipe in said horizontal flue, and connection from the same into the retort.

659,046—October 2, 1900. CHRISTOPHER G. ATWATER. *Coking oven.*

Claims in a coke oven, a coking space shaped like a truncated wedge, base upward, horizontal fire brick passages under each other fitted to the sides of said wedge, so as to widen downward in proportion as the coking space narrows, and burners for introducing gas into said passages at intervals.

668,638—December 11, 1900. HEINRICH POETTER. *Coke oven.*

Claims the combination of coke oven, heating chamber, partitions in the heating chamber, nozzles in the top of chamber above partitions, gas pipe communicating with the nozzles, means for supplying gas to both ends of pipe, an air chamber above the oven, and air passages beside the nozzles and inclined toward each other, so that the air and gas currents meet and commingle above partitions.

668,235—February 19, 1901. FREDERIC W. C. SCHNIEWIND. *Apparatus for manufacturing gas.*

Claims the combination with a multiple series of carbonizing chambers and a common gas collecting main receiving gas therefrom, of gas furnaces arranged to heat the carbonizing chambers, a gas purifying plant connected to the common collecting main and a gas conduit leading from the purifying plant to the gas furnaces and inclosing the gas collecting main aforesaid, whereby the gas coming from the carbonizing chambers is cooled in the collecting main, then purified, then reheated, and then burned in the furnaces.

668,402—February 19, 1901. PORT B. ELKINS. *Coking furnace.*

Claims a coking furnace of heating walls suitably spaced with reference to the formation of coking chambers between adjacent walls, each wall for its entire length, or approximately so, being provided with two series of vertical flues and with two horizontal flues, each connected with the upper ends of one series of vertical flues, and two combustion chambers, each connected to the lower ends of one-half, more or less, of both series of vertical flues.

678,928—May 14, 1901. FREDERIC WILLIAM CHARLES SCHNIEWIND. *Regenerative coke oven.*

Claims a series of coke ovens with heating flues situated between adjacent ovens built up of masonry supported above the ground on metal columns in combination with a pair of regenerators connected with the heating flues of the ovens, said regenerators being situated beneath the ovens and supported on the ground independently of the columns.

679,749—August 6, 1901. LOUIS J. HIRT. *Coke oven.*

Claims in a coking oven, the combination with a vertically arranged oven provided with vertically arranged partition walls separating the said oven into a series of chambers which communicate at their upper ends with a common passage extended across the tops of said chambers, a fuel inlet for said chambers, and a coke outlet for said chambers at their lower ends, substantially horizontal superimposed flues in the opposite side walls of said oven connected at their opposite ends to form a continuous passage, which communicates with the atmosphere at the lower end of said passage, a gas inlet communicating with the said flues at an intermediate point and with the gas outlet for said oven, and means to control the communication of said gas inlet with said gas outlet.

682,441—September 10, 1901. SAMUEL T. WELLMAN AND CHARLES H. WELLMAN. *Coke oven.*

This invention is based upon the discovery that magnesite or carbonate of magnesia (calcined) made into bricks has a very much higher conductivity as a carrier of heat than either clay or silica bricks, having on an average about twice the conductivity of either of the latter. This would be a particularly desirable material from which to form the walls of retort coke ovens; but, unfortunately, these bricks when heated to a high temperature have little strength, will not carry much weight, and under the influence of high temperature are apt to shrink considerably. Consequently, if the inner walls of the ovens were formed entirely of this material, the oven would soon get out of shape, the gases would leak through the walls, and in a short time the ovens would be of such shape that they could not be used at all. To obviate the objections due to its shrinkage and inferior strength when heated, bricks made of magnesite or magnesia are employed in conjunction with clay or silica bricks, or bricks formed of a mixture of magnesite or magnesia with clay or silica are used.

705,446—July 22, 1902. MATHEW E. ROTHBERG. *Coke oven.*

Claims in adjacent coking ovens, a hollow longitudinal wall separating the oven chambers, and longitudinal deflecting partitions forming heating or combustion flues in the cavity or chamber of said wall, and a vertical hot-air flue at the outer ends of said combustion flues, the inner wall of which air flue is pierced for passage of air to the combustion flues.

711,268—October 14, 1902. JOHN F. WILCOX AND DIETRICH E. WAGENER. *Retort coke oven.*

Claims the combination of by-product retort coking ovens heated by gas in the presence of heated air, a hot-air intake flue extending transversely above the ovens and provided with lateral branches lying over the ovens, and combustion chambers contiguous to the upper part of the oven, whereby the expansion due to heat in the flue and chamber may take place without injury to the retorts.

718,037—January 6, 1903. MATHEW E. ROTHBERG. *Coke oven.*

In adjacent coke ovens, a hollow bottom, partitions in the cavity of said bottom and forming transverse reverting combustion flues, a hollow wall separating the oven chambers, a transverse partition dividing the cavity of said wall into two compartments, partitions forming longitudinal reverting combustion flues in said compartments, a reverting hot-air flue leading to said transverse flues, a horizontal draft flue, a hot-air chamber surrounding said draft flue, a hot-air pipe communicating with said reverting hot-air flue, and with said hot-air chamber, said longitudinal combustion flues communicating at one end thereof with said transverse flues, and at the other end thereof with the draft flue.

720,971—February 17, 1903. MATHEW E. ROTHBERG. *Coke oven.*

Claims in adjacent open-end coking ovens, a hollow longitudinal wall separating the oven chambers, longitudinal deflecting partitions forming reverting combustion flues in the cavity or chamber of said wall, alternate partitions having openings therethrough forming short-circuiting passages connecting said flues, and provided with sliding valves, the oven wall having an opening adjacent to each such valve, and plugs for closing such openings.

725,748—April 21, 1903. EDWIN A. MOORE. *Foundation or substructure for coke oven.*

Claims a foundation or substructure for coke ovens, comprising a floor, girders and joists of metal embedded in concrete, and columns of concrete, in combination with metallic tie rods between the girders and the columns.

725,749—April 21, 1903. EDWIN A. MOORE. *Means for protecting coke ovens.*

Claims a coke oven having its sides incased in metallic sections provided with recesses in the rear sides thereof, and heat-nonconducting material in said recesses.

731,088—June 16, 1903. MAHLON UPDIKE. *Retort coke oven.*

Claims in an apparatus of the kind described, a closed retort provided with means for conducting the gases and vapors therefrom and means for charging and discharging the same, and having side walls composed of sectional flue-tiling, the openings through which form oppositely arranged continuous serpentine flues for conducting the products of combustion in close proximity to the retort, a main flue connecting with the inner ends of said flues, and a combustion chamber connecting with the outer ends of the same, in combination with a burner arranged in said combustion chamber and constructed to drive the products of combustion into and through said flues.

731,950—June 23, 1903. JOHN A. POTTER. *Coke oven and gas producer.*

Claims a coke and gas producer of vertical stack form arranged to contain a vertical charge, regenerative flues around its lower portion having gaseous inlets and arranged to heat said gases, a gas offtake at the upper end of the producer and mechanism at the bottom of the producer arranged to shear off and discharge successive portions of the charge.

738,918—September 15, 1903. HEINRICH KOPPERS. *Regenerative coke oven.*

Claims improvement in regenerative coke ovens comprising, in combination with the usual coking chambers and the heating flues, gas regenerators and air regenerators below said coking chambers and heating flues, gas distributing channels below the bottom of the heating flues, air distributing channels below the ovens and with which the air regenerators communicate, covering arches above the heating flues, vertical borings in the bottom of the heating flues placed perpendicularly below the openings in the covering arches of the heating flues, said vertical borings communicating with the gas distributing channels, removable nozzles in said borings, recesses in the side walls of the heating flues close to the bottom of the same, horizontal borings in the side walls of the air channels connecting the same with the recesses in the side walls of the heating flues, nozzles in said horizontal borings, openings in the top wall of the oven above the gas channels at the upper end of the heating flues and removable cover plates closing said openings in the top wall of the oven.

753,149—February 23, 1904. HEINRICH KOPPERS. *Coke oven.*

Claims a coke oven comprising in combination with the usual coking chambers and the heating flues, provided with nozzles at the bottom for the admission of a vertically ascending gas column, inclined channels connecting the air conduits with the base part of the heating flues, the inclination being out of line with the ascending gas column in order to leave it undisturbed and to circulate around it.

754,459—March 15, 1904. ANTHONY C. KLOMAN. *Retort for making gas and coke.*

Claims a coke retort chamber having means for applying heat thereto, said chamber having a bottom inclined in both directions from a middle angular ridge and discharge openings at the ends of said inclined bottoms, the tops of said openings extending to a level above the ridge, and doors closing said discharge openings.

761,789—June 7, 1904. CARL SCHROETTER. *Coke oven.*

This invention relates to improvements in coke ovens of that general type wherein the oven comprises within a single external housing or casing a series of similarly arranged and equipped retorts adapted to treat independent quantities of coal supplied thereto, the several retorts being adapted to effect the coking action solely through the application of external heat, the coking action not being dependent upon heat furnished by combustion within the retorts; and,

The inventor claims in a coke retort of the character specified the top and side walls whereof are formed with an intermediate checkerwork through which the burning fuel and hot products of combustion are circulated, the combination with a combustion chamber directly beneath the sole of the retort, of means for introducing fuel with air under pressure to support combustion directly into the combustion chamber and other means for introducing fuel with air under pressure to support combustion directly into the checkerwork of the side walls.

766,898—August 9, 1904. HEINRICH POETTER. *Horizontal coke oven.*

According to this invention the heating gases are conducted simultaneously from both oven crowns below on each side by a lateral piping and two branched-off gas pipes or more into two or several gas dividing ports, which are disposed below each other, so as to be mutually quite independent. From said gas dividing ports the heating gases pass through vertical nozzles in the heating or combustion ports, in which they become mixed with strongly heated air and are then burned, whereby said gases during their ascension heat one-fourth or less of the oven wall. Owing to this division or distribution of the heating gases into two or several spaces which are completely separated or independent from each other, the result is obtained that said gases flow out from all nozzles with the same pressure, so that all the combustion ports are uniformly heated.

769,531—September 6, 1904. EWALD BREMER. *Oven for coking peat with recovery of by-products.*

Claims an oven for coking peat, comprising a vertically disposed retort, a preliminary drier on the upper end of the retort, adapted to discharge its contents into the retort, a cooling or condensing box at the lower end of the said retort, for receiving the coked peat from the retort, a vertically arranged collecting chamber in the wall of the retort and in communication therewith, for collecting the gases arising in the retort, a gas receiver communicating with the upper end of the collecting chamber, and a combustion chamber in the wall of the retort for burning the said gases after they are regenerated and mixed with air.

770,151—September 13, 1904. THEODOR BAUER. *Coke oven.*

Claims in a battery of adjacent coke ovens, the combination with a plurality of ovens, of a plurality of heating chambers, two on both sides of each oven, each divided by partitions into a plurality of groups of vertical flues, a plurality of air-heating chambers, one between two adjacent heating chambers and one on the side of the external heating chambers of the end ovens, each divided by partitions into a plurality of groups of vertical channels which communicate with the atmosphere by openings and with the flues of the adjacent heating chambers by holes, three main mixing channels placed in the longitudinal direction of the battery above the ovens and the heating chambers and communicating therewith, means for closing and opening the three main mixing channels to the ovens and the heating chambers, means for arbitrarily exhausting the gases from the ovens, a condensing apparatus for purifying the exhausted gases, three tubes with branches for conducting a part of the purified gases from the condensing apparatus to the three main mixing channels, a steam source, means for injecting the purified gases from the branches of the three tubes by means of steam from the steam source into the three main mixing channels, a plurality of horizontal heating flues, one beneath each oven and divided by one partition into halves which communicate with the last flues of the adjacent vertical heating chambers by slots, a plurality of horizontal cooling channels, one beneath each horizontal heating flue and divided by partitions into several parts which communicate by holes with one adjacent air-heating chamber for preliminarily heating the air, two main collecting flues placed along the two longitudinal battery sides and leading to boilers or the like and to a chimney, a plurality of descending flues connecting the horizontal heating flues with the main collecting flues, a plurality of communicating channels connecting the three main mixing channels with each other, a plurality of descending channels connecting the communicating channels with the two main collecting flues, and means for regulating the escape of any excess of gases or mixture from the main mixing channels to the main collecting flues.

782,259—February 14, 1905. CLYDE S. MASON. *Retort coke oven.*

Claims in a retort coking oven, the combination of a series of horizontal retort ovens, combustion chambers below the same, vertical heating flues arranged between adjacent ovens and communicating at their lower ends with the combustion chambers, and a plurality of horizontal flues between adjacent ovens, one of said flues communicating with the upper ends of the vertical flues and another of said flues extending from side to side of the series of ovens, the wall or walls separating said horizontal flues being provided with openings for equalizing the flow of the gases.

793,300—June 27, 1905. MARTIN ZIEGLER. *Kiln for coking peat or similar material.*

Claims a furnace for coking peat and the like having an upright retort of oval or elongated form in cross section and superposed partitions arranged near to the end walls in the interior of the retort, each partition being situated nearer to the end wall of the retort than the one above it, in such a manner that openings are formed between the partitions.

794,662—July 11, 1905. EVENCE COPPÉE. *Coke oven.*

Claims in combination with a series of horizontal externally heated coke ovens, which can be worked with or without recovery of by-products, and having walls constructed similarly in the front and rear of the ovens, gas return passages beneath the ovens distributing the mixture of gas and air arriving from the walls of two contiguous ovens, in variable and adjustable proportions according to the necessities of the working, one part under the floor of one of said ovens and the other part under the floor of the neighboring oven.

797,703—August 22, 1905. FRANZ PALLENBERG AND FRIEDRICH WILHELM SANDMANN. *Coking oven.*

Claims in a coking oven the combination of vertical flues, gas distributing channels beneath the said flues, jets for feeding gas to the said flues, passages parallel to the gas distributing channels, means adjustable from said passages for introducing air into the flues, openings connecting the said flues and passages and rendering the said jets accessible, and means for closing the said openings.

798,089—August 29, 1905. GUSTAV WOLTERS. *Coking furnace.*

Claims in a coking oven, having a series of alternately operated regenerators and alternately operated gas feeds, the combination of a series of chambers formed in the oven walls and means for alternately feeding live gas and air to certain of these chambers in each wall, means for feeding the gases of combustion to the intermediate chambers of the same wall, to which said chambers the live gas was not fed, and means for simultaneously withdrawing waste gas from the latter chambers and vice versa.

804,053—November 7, 1905. MATHEW E. ROTHBERG. *Coke oven.*

Claims a coking oven having in combination a series of adjacent coking chambers, reverting heating flues in the side walls of the coking chambers, a transverse stack draft flue in the foundation at one end of said heating flues, vertical off-gas flues connecting said stack draft flue with said heating flues, a transverse air supply flue in the foundation parallel to said stack draft flue and at the other end of said heating flues, and combustion chambers under the ovens and having connection with said air supply flue.

804,054—November 7, 1905. MATHEW E. ROTHBERG. *Coke oven.*

Claims in double front coke ovens, the combination of hollow longitudinal walls having each a median transverse partition, a set of vertical updraft heating flues and a set of vertical downdraft heating flues upon each side of said partition and extending from front to middle of the ovens, a chamber above each double set of said heating flues and into which they open, said chamber extending from front to middle of the ovens, combustion chambers under the ovens having communication with said updraft heating flues, a common central off-gas flue in the foundation having connection with the downdraft heating flues, and air passages in the foundation having connection with said combustion chambers.

807,532—December 19, 1905. VINCENT G. APPLE. *Coke and gas plant.*

Claims a coke and gas plant comprising two batteries of retorts arranged side by side in lateral alignment, a source of power supply arranged in the space between said batteries, a source of material supply, and means comprising a single continuously operable equipment of transfer devices extending laterally of the retort batteries and said source of material supply for constantly conveying material to the retort, and operating connections between said transfer devices and the source of power.

PETROLEUM REFINING

PETROLEUM REFINING.

By CHARLES E. MUNROE, Professor of Chemistry, George Washington University, Expert Special Agent.

This report deals with those manufacturing establishments in which a variety of marketable products are produced by the treatment of crude petroleum. Establishments which purchase refined or partly refined petroleum products and mix or compound them with vegetable, animal, or mineral oils, or other substances, in order to produce a special composition are not included in this category. Statistics of this industry were first collected in 1880 and were treated in a special report, but they were not then included in the Report on Manufactures. At the censuses of 1890 and 1900 this industry was treated as manufacturing, and it was so considered at the census of 1905. It has been the endeavor to prepare the schedules of inquiry and to compile the tables of results in such a manner that the data for each census are comparable with those for the one preceding.

Table 1 presents the general statistics for the establishments engaged actively in petroleum refining at the censuses from 1880 to 1905, with the amount and per cent of increase in each item for the several periods considered.

TABLE 1.—COMPARATIVE SUMMARY, WITH AMOUNT AND PER CENT OF INCREASE: 1880 TO 1905.

	CENSUS.				INCREASE.			PER CENT OF INCREASE.				
	1905	1900	1890	1880	1900 to 1905	1890 to 1905	1880 to 1905	1900 to 1905	1890 to 1905	1880 to 1905	1890 to 1900	1880 to 1890
Number of establishments	98	[1] 97	[2] 94	86	31	4	12	46.3	4.3	14.0	[3] 28.7	9.3
Capital	$136,280,541	$95,327,892	$77,416,296	$27,325,746	$40,952,649	$58,864,245	$108,954,795	43.0	76.0	398.7	23.1	183.3
Salaried officials, clerks, etc., number	1,074	1,201	[4] 1,068	.....	773	906	.....	64.4	84.8	.....	12.5	.....
Salaries	$2,724,065	$1,811,400	[4] $1,117,011	.....	$912,665	$1,607,054	.....	50.4	143.9	.....	62.2	.....
Wage-earners, average number	16,770	12,199	11,403	9,869	4,571	5,367	6,901	37.5	47.1	69.9	7.0	15.5
Total wages	$9,989,367	$6,717,087	$5,872,467	$4,381,572	$3,272,280	$4,116,900	$5,607,795	48.7	70.1	128.0	14.4	34.0
Men 16 years and over	16,256	11,935	10,885	.....	4,321	5,371	.....	36.2	49.3	.....	9.6	.....
Wages	$9,832,124	$6,673,629	$5,786,737	.....	$3,158,495	$4,045,387	.....	47.3	69.9	.....	15.3	.....
Women 16 years and over	82	66	2	.....	16	80	.....	24.2	4,000.0	.....	3,200.0	.....
Wages	$26,117	$15,570	$622	.....	$10,547	$25,495	.....	67.7	4,098.9	.....	2,403.2	.....
Children under 16 years	432	198	516	.....	234	[3] 84	.....	118.2	[3] 16.3	.....	[3] 61.6	.....
Wages	$131,126	$27,888	$85,108	.....	$103,238	$46,018	.....	370.2	54.1	.....	[3] 67.2	.....
Miscellaneous expenses	$5,297,508	$3,330,851	$2,069,208	[5]	$1,966,657	$3,228,240	.....	59.0	156.0	.....	61.0	.....
Cost of materials used	$139,387,213	$102,859,341	$67,918,723	$34,999,101	$36,527,872	$71,468,490	$104,388,112	35.5	105.2	298.3	51.4	94.1
Value of products	$175,005,320	$123,929,384	$85,001,198	[6] $43,705,218	$51,075,936	$90,004,122	$131,300,102	41.2	105.9	500.4	45.8	94.5

[1] Exclusive of 2 idle establishments, with aggregate capital amounting to $90,000.
[2] Exclusive of 7 idle establishments, with aggregate capital amounting to $423,508.
[3] Decrease.
[4] Includes proprietors and firm members, with their salaries; number only reported in 1900 and 1905, but not included in this table.
[5] Not reported.
[6] Does not include the value of packages made at the refinery.

The term "capital" as used in Table 1 refers only to the sum invested in lands, buildings, machinery, tools, and implements, and the funds required to carry on the business, and does not include capital stock.

The various classes of wage-earners were divided as follows in 1905: Men, 96.9 per cent; women, five-tenths of 1 per cent; children, 2.6 per cent. In 1900 the proportions were 97.8 per cent for men, six-tenths of 1 per cent for women, and 1.6 per cent for children; while in 1890 they were 95.5 per cent for men, less than one-tenth of 1 per cent for women, and 4.5 per cent for children.

Table 2 shows, by states, the number of refineries in operation at each census from 1880 to 1905.

TABLE 2.—*Number of active refineries, by states: 1880 to 1905.*

STATE.	1905	1900	1890	1880
United States	104	75	106	89
California	19	4	2	.....
Colorado	2	2	2	.....
Indiana	1	1	.....	.....
Kansas	1	1	.....	.....
Kentucky	.....	.....	.....	1
Louisiana	1	.....	.....	.....
Maine	.....	.....	.....	1
Maryland	1	1	3	3
Massachusetts	.....	.....	1	5
Michigan	.....	1	.....	.....
New Jersey	6	6	5	2
New York	9	9	16	21
Ohio	12	9	15	18
Pennsylvania	42	39	58	33
Texas	7	1	.....	.....
West Virginia	1	1	4	5
Wyoming	1	.....	.....	.....

The total number of refineries shown in Table 2 differs from the total number of establishments shown for the same census in Table 1. This difference is due to the fact that when two or more refineries in the same city or county are operated by one corporation, firm, or individual, they are considered by the Bureau of the Census as one establishment. The total number of refineries in operation at the different censuses has fluctuated, the number in 1905 being 29, or 38.7 per cent, greater than in 1900; 2, or 1.9 per cent, less than in 1890; and 15, or 16.9 per cent, greater than in 1880.

In 1905 there were 104 refineries distributed among 13 states; in 1900, 75 refineries in 12 states; in 1890, 106 refineries in 9 states; and in 1880, 89 refineries in 9 states. In 1905 Louisiana and Wyoming were added to the list of states in which petroleum is refined. In 4 states—California, Ohio, Pennsylvania, and Texas—the number of refineries in operation in 1905 was greater than in 1900. No refinery was reported in 1905 for Michigan, where 1 was in operation in 1900.

Pennsylvania ranked first in the number of refineries in 1905, a position which this state has held since 1880, when the statistics of this industry were first collected. California, for which statistics were first reported in 1890, ranked second in 1905, displacing Ohio and New York, which jointly held this rank in 1900. Ohio was third, New York fourth, Texas fifth, and New Jersey sixth. In none of the other states were more than 2 refineries in operation in 1905.

Table 3 gives, for the censuses from 1890 to 1905, the details of the capital for the active establishments in the United States, with the amount and per cent of increase; also the number of stills.

TABLE 3.—CAPITAL, WITH AMOUNT AND PER CENT OF INCREASE: 1890 TO 1905.

	CENSUS.			INCREASE.		PER CENT OF INCREASE.		
	1905	1900	1890	1900 to 1905	1890 to 1905	1900 to 1905	1890 to 1905	1890 to 1900
Number of establishments	98	[1] 67	[2] 94	31	4	46.3	4.3	[3] 28.7
Number of stills	1,907	1,774	1,275	133	632	7.5	49.6	39.1
Capital	$136,280,541	$95,327,892	$77,416,296	$40,952,649	$58,864,245	43.0	76.0	23.1
Land	$10,221,401	$8,166,032	$7,886,668	$2,055,369	$2,334,733	25.2	29.6	3.5
Buildings	$9,389,369	$6,502,182	$6,403,994	$2,887,187	$2,985,375	44.4	46.6	1.5
Machinery, tools, and implements	$53,223,807	$39,565,389	$20,837,038	$13,658,418	$32,386,769	34.5	155.4	89.9
Cash and sundries	$63,445,964	$41,094,289	$42,288,596	$22,351,675	$21,157,368	54.4	50.0	[3] 2.8

[1] Exclusive of 2 idle establishments, with aggregate capital amounting to $90,000.
[2] Exclusive of 7 idle establishments, with aggregate capital amounting to $423,508.
[3] Decrease.

Some fluctuation is shown in the number of establishments and in the amount of capital represented by the item "cash and sundries." Every other item in the table shows a steady increase.

Table 4 shows the per cent distribution of capital.

TABLE 4.—*Per cent distribution of capital: 1890 to 1905.*

	1905	1900	1890
Capital	100.0	100.0	100.0
Land	7.5	8.6	10.2
Buildings	6.9	6.8	8.3
Machinery, tools, and implements	39.0	41.5	26.9
Cash and sundries	46.6	43.1	54.6

The proportion of the capital invested in land has decreased steadily. The proportion invested in buildings has decreased since 1890, but was nearly constant at the last two censuses. The proportion invested in machinery, tools, and implements has fluctuated, but was larger in 1905 than in 1890. The proportion of the capital credited to cash and sundries constituted the largest item at each census. It has fluctuated from census to census, but was smaller in 1905 than in 1890.

Table 5 shows the kind, quantity, and cost of the materials used for each census from 1880 to 1905, with the amount and per cent of increase.

TABLE 5.—MATERIALS USED, WITH AMOUNT AND PER CENT OF INCREASE: 1880 TO 1905.

	CENSUS.				INCREASE.			PER CENT OF INCREASE.				
	1905	1900	1890	1880	1900 to 1905	1890 to 1905	1880 to 1905	1900 to 1905	1890 to 1905	1880 to 1905	1890 to 1900	1880 to 1890
Materials used, total cost	$139,387,213	$102,859,341	$67,918,723	$34,999,101	$36,527,872	$71,468,490	$104,388,112	35.5	105.2	298.3	51.4	94.1
Crude petroleum:												
Quantity (barrels of 42 gallons)	66,982,862	52,011,005	30,662,629	17,417,455	14,971,857	36,320,233	49,565,407	28.8	118.5	284.6	69.6	76.0
Cost	$107,487,091	$80,424,207	$44,879,783	$16,340,581	$27,062,884	$62,607,308	$91,146,510	33.7	139.5	557.8	79.2	174.7
Fuel	[1] $5,139,034	$3,120,441	$2,275,468	$1,319,008	$2,019,493	$2,864,466	$3,820,026	64.7	125.9	289.7	37.1	72.5
Acids	$2,304,635	$1,735,782	$1,530,065	$1,206,300	$568,853	$774,570	$1,098,335	32.8	50.6	91.0	13.4	26.8
Barrels, cases, and tin cans (purchased)	$5,880,310	$2,930,805	$4,340,274	$8,388,572	$2,949,505	$1,540,036	[2] $2,508,262	100.6	35.5	[2] 29.9	[2] 32.5	[2] 48.3
Coopers', carpenters', and tinners' materials	$11,990,038	$8,220,928	$12,495,600	$7,576,055	$3,769,110	[2] $505,562	$4,413,983	45.8	[2] 4.0	58.3	[2] 34.2	64.9
Mill supplies	$403,886	$228,926	[3]	[3]	$174,960			76.4				
All other materials	$5,666,501	$3,300,851	[4] $2,397,533	$168,585	$2,365,650	$3,268,968	$5,497,916	71.7	136.3	3,261.2	37.7	1,322.2
Freight	$514,818	$2,897,401	[3]	[3]	[2] $2,382,583			[2] 82.2				

[1] Includes $3,668 for rent of power and heat.
[2] Decrease.
[3] Not reported separately.
[4] Includes $127,205, the value of residuum and naphtha used as materials.

The total cost and quantity of crude petroleum used at each census has increased steadily, though not in the same proportion for each. The increase in cost for 1890 over 1880 was $28,539,202; for 1900 over 1890, $35,544,424; and for 1905 over 1900, $27,062,884. The increase in quantity for 1890 over 1880 was 13,245,174 barrels; for 1900 over 1890, 21,348,376 barrels; and for 1905 over 1900, 14,971,857 barrels. While in commerce crude petroleum is measured by barrels of 42 United States (Winchester) gallons, refined petroleum is measured by barrels of 50 United States gallons.[1]

Under the term "acids," as used in Table 5, were included at each census a number of different chemical substances. In 1905 the term included sulphuric acid, alkali, sulphur, and pyrites; in 1900, acids, alkalies, and sulphur; in 1890, sulphuric and all other acids; and in 1880, sulphuric acid, hydrochloric acid, and sulphur. In 1905 the quantity of sulphuric acid used in refining the crude petroleum was reported in two items—162,152 short tons were purchased and 49,379 short tons were produced in the refineries and consumed in refining. In all, 211,531 tons, or 423,062,000 pounds, were used. In 1890, 95,916 tons, or 191,832,000 pounds, were used; and in 1880, 45,820 tons, or 91,640,000 pounds. No separate returns were secured for this item at the census of 1900. The quantity of sulphuric acid used in refining in 1905 was 115,615 tons, or 120.5 per cent, greater than in 1890, and 165,711 tons, or 361.7 per cent, greater than in 1880. In 1905, 1 pound of sulphuric acid was used to 6.6 gallons of crude petroleum; in 1890, 1 pound to 6.7 gallons; and in 1880, 1 pound to 8 gallons.

In the case of many of the returns the cost of freight is included in the cost given for the separate items of materials used.

[1] As a gallon of the crude petroleum found in the United States varies in weight from 6.41 to 7.83 pounds, the oil in a barrel varies from 269.22 to 328.86 pounds.

At each census the cost of the crude petroleum has formed the largest proportion of the total cost of materials used, although in 1880 it exceeded that for containers by only 1.1 per cent. In 1880 it formed 46.7 per cent of the total cost; in 1890, 66.1 per cent; and in 1900, 78.2 per cent; but in 1905 it fell to 77.1 per cent. The cost of containers, as set forth in Table 5, embraces two items: First, the packages purchased, such as barrels, tin cans, and cases; and second, the coopers', carpenters', and tinners' materials, from which containers are manufactured within the establishments. Evidently the final cost of the containers made from the last enumerated materials would be greater by the cost of the labor, fuel, and the like expended upon them. These items of cost appear in totals in their assigned places in Table 1 and Table 5. There is no information at command which permits of their being apportioned to their several duties.

The proportion which the cost of fuel formed of the total cost of materials used at the different censuses was: In 1880, 3.8 per cent; in 1890, 3.3 per cent; in 1900, 3 per cent; and in 1905, 3.7 per cent—the average for the four censuses being 3.4 per cent. The proportion of acids decreased from 3.4 per cent in 1880 to 1.6 per cent in 1900. The proportion of "all other materials" increased steadily from five-tenths of 1 per cent in 1880 to 4.1 per cent in 1905.

The combined amount of the total cost of materials used and total wages was: At the census of 1880, $39,380,673; of 1890, $73,791,190; of 1900, $109,576,428; and of 1905, $149,376,580. The proportion which the cost of the crude petroleum used bore to this combined total was: At the census of 1880, 41.5 per cent; of 1890, 60.8 per cent; of 1900, 73.4 per cent; and of 1905, 72 per cent. The proportion which the total wages bore to this combined total was: At the census of 1880, 11.1 per cent; of 1890, 8 per cent; of 1900, 6.1 per cent; and of 1905, 6.7 per cent.

Table 6 presents statistics concerning the equipment of plants by states in 1890, 1900, and 1905.

TABLE 6.—EQUIPMENT OF PLANT, BY STATES: 1890 TO 1905.

STATE.	Census.	BUILDINGS.							POWER.					Presses.	STORAGE TANKS.[1]	
		Cooper shops.	Tinsmith shops.	Stills.			Agitators.	Chilling houses for paraffin.	Total horsepower.	Engines.		Electric motors.	Pumps, etc., and allied equipments.		For crude petroleum.	For refined petroleum.
				Heated by steam.	Heated by superheated steam.	Heated by fire.				Steam.	Gas and gasoline.					
United States	1905	64	17	282	15	1,610	374	67	49,337	1,072	57	224	41	311	304	3,575
	1900	48	13	200	26	1,458	327	48	37,052	864	28	69	[2] 194	510	257	2,860
	1890	31	20	217	61	997	306	39	36,281	545	[3]	[3]	[3]	767	292	1,861
California [4]	1905	11	2	14	.....	92	47	1	1,323	25	1	6	15	2	43	375
	1900	2	1	9	6	22	7	1	180	4	1	.....	20	2	12	62
New Jersey	1905	5	5	33	.....	339	52	3	10,059	172	1	31	.....	34	27	460
	1900	9	4	42	8	303	64	10	12,048	121	.....	27	129	123	32	497
	1890	4	1	23	.....	188	52	6	11,036	220	.....	.....	.....	86	22	375
Ohio	1905	7	1	32	1	184	52	8	4,406	140	5	2	5	41	20	499
	1900	5	1	32	1	189	53	8	2,491	65	.....	.....	.....	54	24	275
	1890	4	2	34	17	163	54	6	5,997	63	.....	.....	.....	174	28	172
Pennsylvania	1905	30	3	112	4	400	120	48	13,208	311	46	60	21	124	131	1,191
	1900	25	2	106	8	414	113	21	13,328	470	25	5	[2] 45	208	152	1,198
	1890	12	3	86	36	305	98	17	8,223	164	.....	.....	.....	133	161	707
All other states [5]	1905	11	6	91	10	595	103	7	19,681	424	4	125	.....	110	83	1,110
	1900	7	5	101	3	530	90	8	9,005	204	2	37	.....	123	40	857
	1890	11	14	74	8	341	102	10	11,025	98	.....	.....	.....	374	81	607

[1] Not intended to cover tanks used in marketing the products, though possibly some such are included.
[2] Includes 1 refrigerating machine.
[3] Not reported separately.
[4] In 1890 included in "all other states."
[5] Includes establishments distributed as follows: 1905—Colorado, 2; Indiana, 1; Kansas, 1; Louisiana, 1; Maryland, 1; New York, 5; Texas, 7; West Virginia, 1; Wyoming, 1; 1900—Colorado, 2; Indiana, 1; Kansas, 1; Maryland, 1; Michigan, 1; New York, 4; Texas, 1; West Virginia, 1; 1890—California, 2; Colorado, 2; Maryland, 2; Massachusetts, 1; New York, 9; West Virginia, 4.

The total number of engines of all kinds in 1905 was greater than in 1900 by 237, or 26.6 per cent, and greater than in 1890 by 584, or 107.2 per cent. The gasoline engines in 1905 constituted 5 per cent of the total number of engines and in 1900, 3.1 per cent. The number of electric motors reported in 1905 was greater than in 1900 by 155, or 224.6 per cent, while the number of pumps and related machines was less by 153, or 78.8 per cent.

Table 7 shows the details of the industry, as to the kind, quantity, and value of products, and the average price per barrel for each census from 1880 to 1905.

TABLE 7.—PRODUCTS, BY KIND, QUANTITY, AND VALUE: 1880 TO 1905.

PRODUCT.	1905			1900			1890			1880		
	Number of barrels.	Value.	Average value per barrel.	Number of barrels.	Value.	Average value per barrel.	Number of barrels.	Value.[1]	Average value per barrel.	Number of barrels.	Value.[1]	Average value per barrel.
Burning oils	34,311,522	$100,571,825	$2.93	31,266,513	$82,244,961	$2.63	16,967,397	$47,842,537	$2.82	11,002,249	$36,839,613	$3.35
Residuum	3,187,921	3,138,361	0.98	596,615	688,455	1.15	1,194,967	1,235,490	1.03	229,133	297,529	1.30
Paraffin oils	1,644,400	6,210,270	3.78	1,606,783	3,987,037	2.48	684,849	3,022,048	4.41	79,465	408,023	5.13
Paraffin wax	794,068	10,007,274	12.60	774,924	7,791,149	10.05	241,951	2,904,902	12.01	[2] 20,856	631,944	30.30
Reduced oils	[3] 4,252,248	16,794,789	3.86	[3] 1,766,090	7,108,168	4.03	856,730	2,333,923	2.72	230,859	1,395,037	6.04
Naphtha and gasoline	5,811,289	21,314,837	3.67	5,615,554	15,991,742	2.85	3,290,462	7,115,388	2.16	1,502,181	2,961,561	1.97
Neutral filtered oils	504,042	1,942,153	3.85	608,185	2,256,626	3.71	.....	.....	.....	.....	.....	.....
All other products [4]	.....	15,025,802	.....	.....	3,861,246	.....	.....	[5] 20,546,910	.....	.....	1,171,511	.....

[1] The cost of packages was not uniformly included in the value of products for 1880 and 1890. This should be considered in connection with the average value per barrel.
[2] Reported as 7,889,626 pounds in 1880, but the figures were converted into barrels on the assumption that the average weight of paraffin in a 50-gallon barrel is 378.3 pounds.
[3] Includes filtered cylinder oils and greases.
[4] Includes coke, carbon points, and black naphtha.
[5] Includes $15,258,054, the value of packages made at the refinery.

The number of products which may be obtained from petroleum in the process of refining is very large, the number actually obtained commercially being so great as to render it impracticable to obtain returns in detail for all of them. Consequently a somewhat arbitrary, but well recognized, classification has been adopted. For instance, all of the various grades of illuminating oil and fuel oil are combined under the head of burning oils. The classification followed in Table 7 is that used in the Eleventh and Twelfth censuses. It differs somewhat from that used in the Tenth Census, this change being due to the manner in which the industry has developed. The returns for the earlier censuses have been grouped in this table in

as close conformity as possible with the returns for the later censuses. Where products have been reported which did not conform with this classification, they have been included in the item "all other products." No attempt has been made in collecting the statistics for the later censuses to extend the inquiry in detail to embrace vaseline or cosmoline, and other minor products, or candles and compounds or compositions of various kinds, but the values for these are included in "all other products."

The amount and per cent of increase in the total value of the products for 1905 over that for each of the previous censuses has been given in Table 1. The total value of products was greater than the cost of the crude petroleum from which they were produced by $67,518,229 in 1905; by $43,505,177 in 1900; by $40,121,415 in 1890; and by $27,364,637 in 1880.

In comparing values at different censuses it is to be borne in mind that a larger percentage of oil is now shipped in bulk than was formerly the case.

Table 8 shows for each item presented in Table 7, the amount and per cent of increase for the censuses from 1880 to 1905.

TABLE 8.—PRODUCTS, WITH AMOUNT AND PER CENT OF INCREASE IN QUANTITY AND VALUE: 1880 TO 1905.

PRODUCT.	INCREASE.						PER CENT OF INCREASE.					
	1900 to 1905		1890 to 1905		1880 to 1905		1900 to 1905		1890 to 1905		1880 to 1905	
	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity (barrels).	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Burning oils	3,078,009	$18,326,864	17,377,125	$52,720,288	23,342,273	$63,732,212	9.8	22.3	102.4	110.0	212.2	173.0
Residuum	2,591,306	2,449,906	1,992,954	1,902,871	2,958,788	2,840,832	434.3	355.9	166.8	154.0	1,291.3	954.8
Paraffin oils	37,617	2,223,242	959,551	3,188,231	1,564,935	5,802,256	2.3	55.8	140.1	105.5	1,969.3	1,422.0
Paraffin wax	19,144	2,216,125	552,117	7,102,372	[1] 773,212	9,375,330	2.5	28.4	228.2	244.5	[13] 7,707.4	1,483.6
Reduced oils	2,586,158	9,686,621	3,495,518	14,460,866	4,121,389	15,399,752	146.4	136.3	408.0	619.6	1,785.2	1,103.9
Naphtha and gasoline	195,735	5,323,095	2,520,827	14,199,449	4,309,108	18,353,276	3.5	33.3	76.6	199.6	286.9	619.7
Neutral filtered oils	[2] 104,143	[2] 314,473					[2] 17.1	[2] 13.9				
All other products		11,164,556		[2] 5,521,108		13,854,261		289.1		[2] 26.9		1,182.6

[1] Reported as 7,889,626 pounds in 1880, but the figures were converted into barrels on the assumption that the average weight of paraffin in a 50-gallon barrel is 378.3 pounds.
[2] Decrease.

Table 9 shows the percentage which the quantity of each product formed of the total quantity of crude petroleum used, for the censuses from 1880 to 1905.

TABLE 9.—*Per cent distribution of crude petroleum among the several products: 1880 to 1905.*

	1905	1900	1890	1880
Burning oils	61.0	71.6	65.9	75.2
Residuum	5.7	1.4	4.6	1.6
Paraffin oils	2.9	3.7	2.7	0.5
Paraffin wax	1.4	1.8	0.9	0.1
Reduced oils	7.7	4.0	3.3	1.6
Naphtha and gasoline	10.3	12.9	12.8	10.3
Neutral filtered oils	0.9	1.4	.....	.....

Table 10 shows the percentage which the value of each product formed of the total value of all products, for the censuses from 1880 to 1905.

TABLE 10.—*Per cent distribution of the value of products: 1880 to 1905.*

	1905	1900	1890	1880
All products	100.0	100.0	100.0	100.0
Burning oils	57.5	66.4	56.3	84.3
Residuum	1.8	0.6	1.4	0.7
Paraffin oils	3.5	3.2	3.6	0.9
Paraffin wax	5.7	6.3	3.4	1.4
Reduced oils	9.6	5.7	2.7	3.2
Naphtha and gasoline	12.2	12.9	8.4	.....
Neutral filtered oils	1.1	1.8	.....	6.8
All other	8.6	3.1	24.2	2.7

The total volume of refined products for which quantities were reported was, in 1905, 50,638,490 barrels (of 50 United States gallons); in 1900, 42,234,664 barrels; in 1890, 23,236,356 barrels; and in 1880, 13,157,570 barrels. Using these figures, it appears that in 1905 1 pound of sulphuric acid was used in refining for every 5.9 gallons of products obtained; in 1890, 1 pound for every 6.1 gallons; and in 1880, 1 pound for every 7.2 gallons. It is evident that these proportions are to some degree affected by the variations in "all other products." Taking the single item "burning oils," it appears that in 1905, 1 pound of sulphuric acid was used for every 4.1 gallons of burning oils produced; in 1890, 1 pound for every 4.4 gallons; and in 1880, 1 pound for every 6 gallons.

At the outset of the preparation of this report it was planned to present separate statistics for illuminating oils and fuel oils, since in the public mind they represent, because of their uses, two different classes of products, and the inquiry was made with this in view. Careful consideration of the returns and of the development of the industry indicates that this separation can not be made with much precision, and even suggests that the illuminating oil shown separately at the census of 1880 included oil used as fuel.

The use of petroleum oils for fuel is old. In the report on the Production, Technology, and Uses of Petroleum and its Products for the Census of 1880 it is stated [1] that "Petroleum and nearly all its products and natural gas are used in glass houses for producing

[1] Page 251.

high temperatures and flames free from soot and other materials that would injure the glass;" also "The kerosene stoves are being brought to a great degree of perfection and are found to be very useful. * * * These stoves act best with high-test oil and are therefore safe. Their healthfulness depends upon the manner in which they are used. * * * Yet they are cheap and convenient, are used by tens of thousands, and their use is increasing." For fuel purposes a kerosene may be used which is less completely refined than that used for lamps, especially so when the oil is used under steam generators and the same fraction in a different condition of purity might be styled illuminating oil or fuel oil, from a consideration of the purposes to which it is to be put. In the progress of the art, the residuum came to be used as fuel. In the report on the Refining of Petroleum for the Census of 1890 it is stated:[1] "Of the residuum reported as fuel, 399,243 barrels were consumed in the refineries located in the state of New York." As described further on, certain petroleum residuums have for a long time been treated for the production of lubricating oils and paraffin products, though they may be "cracked" to produce burning oils. This latter method of treatment was described in 1872 by S. Dana Hayes.[2] Since the census of 1900 was taken, beginning with the opening of the Lucas well at Beaumont, Tex., a grade of petroleum has been made accessible, in large quantity, whose residuum finds use as a fuel oil; and the development of the California field, in which a somewhat related petroleum is found, has led to such an increase in its use that it has become an important factor. These petroleums give such different yields and yield certain products so different from those obtained from the crude petroleums employed before these fields were operated, that it is believed confusion has been introduced into the trade and into the returns in the designation of fuel oils and also of residuum. The confusion in the use of the term "fuel oil" is the greater because crude petroleum, especially that from the southeastern Texas and Louisiana field and from California, is also used extensively as fuel.

The petroleum distillates of various grades have also come into extended use as the source of energy in explosion engines. As early as 1872[3] the Brayton engine, which was the first in which kerosene was employed, was patented in the United States, and the use of these heavier distillates for engine fuel has materially increased from that time. Oil for this use may be reported as engine distillate, or even as gas oil.

[1] Page 363.
[2] On the history and manufacture of petroleum products. Am. Chemist, vol. 2, pages 401 to 405.
[3] Redwood, Petroleum, vol. 2, page 725.

In consideration of these conditions, the term "burning oils," introduced in the census classification of this industry in 1890, has been retained notwithstanding that, according to Hayes,[4] the term "burning oils" was originally applied to the kerosenes. According to the present Census use, this term embraces all petroleum distillates employed for the production of light, heat, or power, other than the "naphthas and gasolines," and it has this significance in the table.

Premising that, for the census of 1905 at least, these statistics are to an extent the result of estimates, it may be stated that at the census of 1905 there were produced 27,135,094 barrels of illuminating oils, having a value of $91,366,434, and 7,209,428 barrels of fuel oils, having a value of $9,205,391. At the census of 1900 there were produced 25,171,289 barrels of illuminating oils, having a value of $74,694,297, and 6,095,224 barrels of fuel oils, having a value of $7,550,664. The increase in the quantity of illuminating oils for 1905 over 1900 was 1,963,805 barrels, and the increase in value was $16,672,137. The increase in the quantity of fuel oils for 1905 over 1900 was 1,114,204 barrels, and the increase in value was $1,654,727.

The statistics obtained for residuum are, for reasons similar to those given above, regarded as open to question, it being doubtful if the same "fraction" is returned by different establishments under this category. There can be no question that with the use of the Texas and California petroleums in refining, a considerable part of the residuum is different from that obtained from the Pennsylvania and similar petroleums. Hence the statistics for the present census are not strictly comparable with those for previous censuses. The difficulties here set forth do not obtain with the statistics for the total products as they do for the separate ones.

The total volume of refined products for which quantities were reported in 1905 aggregated 50,638,490 barrels of 50 United States gallons. Of this quantity, 34,344,522 barrels were burning oils, and 5,811,289 barrels were naphtha and gasoline. These three classes of products constituted the principal products when rated by quantity, while burning oils and naphtha and gasoline were the principal products when rated by value.

The total quantity of crude petroleum produced in the United States in 1904, according to the reports to the United States Geological Survey, was 117,063,421 barrels (of 42 United States gallons), of which 2,647,060 barrels were exported. The quantity of crude oil reported as used by the refineries was 66,982,862 barrels, which leaves 47,433,500 barrels added to stocks

[4] Loc. cit.

of crude oil, or lost by leakage, fire, or other accident, or otherwise to be accounted for. The corresponding remainder obtained by a similar computation with the data of the census of 1900 was 2,257,846 barrels. The fact that this amount not definitely accounted for was larger at the census of 1905 may be to a degree attributed to the increased use in recent years of crude petroleum for fuel and for other purposes.

The total quantity of refined products reported separately on the census schedules for 1905 amounted to 50,638,490 barrels of 50 gallons each, which would be equivalent to 60,283,917 barrels of 42 gallons. Deducting this from the 66,982,862 barrels of crude petroleum reported as used by refineries there is a difference of 6,698,945 barrels of 42 gallons each, or 5,627,114 barrels of 50 gallons each. This difference represents to some degree the quantity of crude petroleum used in the manufacture of "all other products." In 1900 this quantity was represented by 1,731,644 barrels of 42 gallons. This volume is somewhat in excess of the true quantity used for "all other products," since all manufacturing processes are accompanied by some necessary waste and in the processes of refining by destructive distillation it is practically impossible to prevent the formation of gases and vapors which escape condensation.

Table 11 shows for 1880 and for each year between 1889 and 1904 the total production of crude petroleum, as taken from the reports of the United States Geological Survey, and the exports of crude and refined oils, as obtained from the reports of the Bureau of Statistics of the Department of Commerce and Labor, the latter being converted from the fiscal year to the calendar year.

TABLE 11.—PRODUCTION OF CRUDE PETROLEUM, AND EXPORTS OF CRUDE AND REFINED OILS, FROM 1889 TO 1904, AND FOR 1880.

YEAR ENDING DECEMBER 31—	Production (barrels of 42 gallons).	EXPORTS.[1]											
		Total.		Crude, including all natural oils, without regard to gravity.		Refined or manufactured.						Residuum, tar, pitch, and all other, from which the light bodies have been distilled.		Paraffin and paraffin wax (value).
						Naphthas, benzine, gasoline, etc.		Illuminating.		Lubricating and heavy paraffin oil.				
		Barrels of 50 gallons.	Value.	Barrels of 50 gallons.	Value.	Barrels of 50 gallons.	Value.	Barrels of 50 gallons.	Value.	Barrels of 50 gallons.	Value.	Barrels of 50 gallons.	Value.	
1904.	117,063,421	20,442,325	$80,624,207	2,223,530	$6,350,682	499,788	$2,321,714	15,227,163	$58,384,273	1,793,762	$12,393,382	698,082	$1,174,156	$8,272,856
1903.	100,461,337	18,733,945	72,628,539	2,530,234	6,782,150	259,463	1,518,541	13,836,744	51,355,668	1,912,439	12,690,051	195,065	282,129	9,596,308
1902.	88,766,916	21,284,672	68,597,143	2,904,674	6,331,011	393,653	1,392,771	15,576,020	49,079,055	1,644,010	10,872,154	766,315	922,152	8,398,450
1901.	69,389,194	21,581,490	72,784,912	2,540,160	6,037,544	433,695	1,741,547	16,549,589	53,490,713	1,506,119	10,260,125	551,927	1,254,983	7,959,991
1900.	63,620,529	19,737,129	74,493,707	2,763,223	7,340,749	371,410	1,681,201	14,783,269	54,692,872	1,424,227	9,933,548	395,000	845,337	8,185,518
1899.	57,070,850	19,020,488	64,982,249	2,353,679	5,957,829	358,080	1,557,607	14,491,259	48,466,200	1,386,584	8,344,735	430,886	655,878	7,650,449
1898.	55,364,233	19,729,612	52,551,048	2,298,302	4,764,111	340,532	1,053,231	15,223,042	38,542,082	1,279,307	7,385,054	588,369	806,570	6,362,871
1897.	60,476,516	19,885,954	59,057,547	2,429,774	5,020,968	268,606	994,781	15,918,390	46,229,579	1,024,566	6,478,479	244,618	333,740	5,283,929
1896.	60,960,361	17,809,179	62,383,403	2,218,472	6,121,836	246,986	1,059,542	14,329,111	48,630,920	1,010,511	6,556,775	4,099	14,330	4,563,168
1895.	52,892,276	17,690,041	46,660,082	2,225,705	5,161,710	290,024	910,988	14,297,183	34,706,844	868,379	5,867,477	2,750	13,063	4,504,912
1894.	49,344,516	18,165,045	41,499,806	2,438,527	4,415,915	311,115	943,970	14,607,372	30,676,217	803,811	5,449,000	4,220	14,704	3,276,837
1893.	48,412,666	16,084,424	42,142,058	2,234,070	4,567,391	346,080	1,074,710	12,844,796	31,719,404	648,657	4,738,892	10,821	41,661	4,552,543
1892.	50,509,136	14,892,770	42,729,157	2,087,942	4,696,191	327,866	1,037,558	11,788,364	31,826,545	680,537	5,130,643	8,061	38,220	4,159,538
1891.	54,291,980	13,478,111	46,174,835	1,934,456	5,365,579	228,500	858,137	10,628,902	34,879,759	666,205	4,999,978	20,048	61,382	3,978,884
1890.	45,822,672	13,876,597	52,270,953	1,931,453	6,535,499	249,253	1,050,013	11,017,468	39,826,086	641,811	4,766,850	36,612	91,905	2,920,262
1889.	35,163,513	13,614,108	53,293,299	1,703,793	6,134,002	279,688	1,208,116	11,035,393	41,215,192	558,065	4,638,724	37,169	97,265	2,287,760
1880.	26,286,123	6,935,588	34,505,645	734,962	2,772,400	302,302	1,344,529	5,722,631	29,047,908	112,140	1,141,825	63,553	198,983	[2]

[1] Compiled from reports of the Bureau of Statistics, Department of Commerce and Labor.

[2] Not reported separately.

Table 11 shows that in 1904, 18,218,795 barrels of refined products, or 36.6 per cent of the total for that year, were exported. In 1899, 16,666,809 barrels, or 39.5 per cent of the refined product for the year, were exported. The total value at the ports of shipment of the refined petroleum exported in 1904 was $74,273,525. Although the quantity was greater in 1901 and 1902, this is the largest value ever reported for refined petroleum exported, and it exceeds the value of that exported in 1899 by $15,249,105, or 25.8 per cent; of that exported in 1889 by $27,114,228, or 57.5 per cent; and of that exported in 1880 by $42,540,280, or 134.1

per cent. Taking the quantity of the crude petroleum produced as shown for the census years in Table 11, and the quantity used in refineries as reported in Table 5, the proportion of the total crude petroleum refined at the census of 1905 was 57.2 per cent; in 1900, 81.8 per cent; in 1890, 66.9 per cent; and in 1880, 66.3 per cent.

Notwithstanding the extent of the exports of petroleum and petroleum products from the United States, mineral oils and paraffin to a limited extent are imported. It is probable that these are special articles, and that the paraffin is largely from other sources than petroleum. This importation is shown by quantity and value in Table 12.

TABLE 12.—*Imports of mineral oils and paraffin:*[1] *1901 to 1905.*

YEAR.	MINERAL OILS.		PARAFFIN.	
	Gallons.	Value.	Gallons.	Value.
1905	10,000,502	$494,221	1,425,074	$73,435
1904	4,653,508	280,746	1,224,392	65,040
1903	3,708,127	227,217	2,654,716	149,479
1902	3,235,467	193,076	[2] 754,265	44,332
1901	2,147,938	172,465	[2] 255,603	17,551

[1] "Commerce and Navigation of the United States," Bureau of Statistics, Department of Commerce and Labor. Each of these articles is dutiable if imported from countries which impose duty on like articles imported from the United States; otherwise, free. Part of these imports in each year paid duty.

[2] Includes only the quantity on which no duty was paid. The value was reported and is included in the aggregate value for the year.

Table 13 presents by states the detailed statistics of petroleum refining for 1905.

TABLE 13.—PETROLEUM REFINING—DETAILED SUMMARY, BY STATES: 1905.

	United States.	California.	Ohio.	Pennsylvania.	All other states.[1]
Number of establishments	98	19	12	43	24
Capital:					
Total	$136,280,541	$5,453,012	$10,384,741	$32,846,578	$87,596,210
Land	$10,221,401	$520,017	$694,604	$1,583,414	$7,423,366
Buildings	$9,389,369	$459,915	$742,333	$2,464,759	$5,722,362
Machinery, tools, and implements	$53,223,807	$1,900,860	$3,214,746	$11,064,990	$36,443,211
Cash and sundries	$63,445,964	$2,572,220	$5,733,058	$17,133,415	$38,007,271
Proprietors and firm members	24	.....	.....	22	2
Salaried officials, clerks, etc.:					
Total number	1,974	162	216	408	1,188
Total salaries	$2,724,065	$211,752	$266,171	$556,501	$1,689,641
Officers of corporations—					
Number	152	16	20	50	66
Salaries	$612,428	$48,475	$60,480	$138,565	$364,908
General superintendents, managers, clerks, etc.—					
Total number	1,822	146	196	358	1,122
Total salaries	$2,111,637	$163,277	$205,691	$417,936	$1,324,733
Men—					
Number	1,692	130	185	322	1,055
Salaries	$2,041,076	$154,346	$200,591	$396,532	$1,289,607
Women—					
Number	130	16	11	36	67
Salaries	$70,561	$8,931	$5,100	$21,404	$35,126
Wage-earners, including pieceworkers and total wages:					
Greatest number employed at any one time during the year	19,621	867	2,181	4,922	11,651
Least number employed at any one time during the year	13,713	582	1,694	3,411	8,026
Average number	16,770	678	1,900	4,227	9,965
Wages	$9,989,367	$477,118	$1,053,598	$2,371,027	$6,087,624
Men 16 years and over—					
Average number	16,256	678	1,717	4,112	9,749
Wages	$9,832,124	$477,118	$999,040	$2,342,811	$6,013,155
Women 16 years and over—					
Average number	82	.....	54	2	26
Wages	$26,117	.....	$18,602	$557	$6,958
Children under 16 years—					
Average number	432	.....	129	113	190
Wages	$131,126	.....	$35,956	$27,659	$67,511
Average number of wage-earners, including pieceworkers, employed during each month:					
Men 16 years and over—					
January	16,158	573	1,869	4,331	9,385
February	16,247	617	1,849	4,253	9,528
March	16,798	630	1,801	4,309	10,058
April	16,431	689	1,594	4,355	9,793
May	16,668	695	1,636	4,383	9,954
June	17,117	778	1,734	4,228	10,377
July	16,921	816	1,830	4,011	10,264
August	16,635	743	1,658	3,962	10,272
September	16,278	687	1,659	4,092	9,840
October	15,883	649	1,676	4,031	9,527
November	15,339	602	1,686	3,791	9,260
December	14,597	657	1,612	3,598	8,730
Women 16 years and over—					
January	88	.....	59	2	27
February	83	.....	55	2	26
March	85	.....	51	2	32
April	82	.....	49	2	31
May	67	.....	45	2	20
June	70	.....	45	2	23
July	64	.....	38	2	24
August	65	.....	36	2	27
September	73	.....	49	2	22
October	102	.....	74	2	26
November	103	.....	74	2	27
December	102	.....	73	2	27
Children under 16 years—					
January	425	.....	135	114	176
February	427	.....	134	116	177
March	407	.....	133	108	166
April	424	.....	134	120	170
May	443	.....	125	157	161
June	433	.....	109	134	190
July	405	.....	124	57	224
August	466	.....	127	93	246
September	499	.....	129	141	229
October	496	.....	134	127	235
November	403	.....	133	109	161
December	368	.....	131	80	157

[1] Includes establishments distributed as follows: Colorado, 2; Indiana, 1; Kansas, 1; Louisiana, 1; Maryland, 1; New Jersey, 4; New York, 5; Texas, 7; West Virginia, 1; Wyoming, 1.

TABLE 13.—PETROLEUM REFINING—DETAILED SUMMARY, BY STATES: 1905—Continued.

	United States.	California.	Ohio.	Pennsylvania.	All other states.
Miscellaneous expenses:					
Total	$5,297,508	$146,719	$752,712	$1,218,572	$3,179,505
Rent of works	$40,568	$2,525	$5,303	$3,731	$28,919
Taxes, not including internal revenue	$572,663	$15,225	$79,030	$49,979	$428,429
Rent of offices, interest, insurance, and all other sundry expenses not hitherto included	$4,635,029	$128,919	$667,504	$1,159,400	$2,679,206
Contract work	$49,248	$50	$785	$5,462	$42,951
Materials used:					
Total cost	$139,387,213	$4,130,809	$7,662,397	$38,921,919	$88,672,088
Crude petroleum—					
Barrels of 42 gallons	66,982,862	4,369,600	4,195,871	17,977,686	40,439,705
Cost	$107,487,691	$3,431,754	$5,143,137	$31,957,135	$66,955,665
Sulphuric acid—					
Short tons	162,152	13,103	10,787	45,177	93,085
Cost	$2,003,031	$316,831	$120,594	$489,741	$1,075,865
Caustic soda—					
Pounds	11,161,376	469,929	1,005,404	2,680,308	7,005,735
Cost	$208,440	$10,018	$17,389	$54,987	$126,055
Sulphur—					
Short tons	888	843	43	----	2
Cost	$13,380	$11,437	$1,871	----	$72
Pyrites—					
Long tons	20,661	----	2,833	3,780	14,048
Cost	$79,784	----	$14,247	$18,910	$46,627
Coopers' and carpenters' materials, cost	$5,628,274	$6,542	$362,970	$569,458	$4,689,304
Tinners' materials, cost	$6,361,764	$10	$140,817	$1,001,930	$5,219,007
Barrels, cases, and tin cans (purchased), cost	$5,880,310	$124,852	$432,872	$1,613,024	$3,709,562
Fuel	$5,136,266	$191,386	$497,738	$1,543,851	$2,903,291
Rent of power and heat	$3,668	$1,377	----	----	$2,291
Mill supplies	$403,886	$2,368	$21,814	$133,991	$245,713
All other materials	$5,666,501	$21,977	$908,792	$1,187,618	$3,548,114
Freight	$514,818	$12,257	$165	$351,274	$151,122
Products consumed:					
Sulphuric acid, short tons	49,379	1,988	5,665	8,398	33,328
Products:					
Total value	$175,005,320	$5,748,598	$10,948,864	$47,459,502	$110,848,356
Burning oils—					
Barrels of 50 gallons	34,344,522	1,370,149	1,961,105	9,977,418	21,026,850
Value	$100,571,825	$2,641,916	$5,188,808	$28,412,940	$64,328,161
Residuum—					
Barrels of 50 gallons	3,187,921	2,152,437	111,339	152,282	771,863
Value	$3,138,361	$1,667,414	$210,911	$408,434	$851,402
Paraffin oils—					
Barrels of 50 gallons	1,644,400	20,666	114,201	371,724	1,137,809
Value	$6,210,279	$120,077	$411,121	$1,173,727	$4,505,354
Reduced oils—					
Barrels of 50 gallons	2,783,148	17,504	150,160	626,449	1,989,026
Value	$6,068,360	$57,602	$586,258	$1,684,169	$3,740,331
Neutral filtered oils—					
Barrels of 50 gallons	504,042	114	300	253,874	249,754
Value	$1,942,153	$290	$2,900	$754,370	$1,184,593
Filtered cylinder oils—					
Barrels of 50 gallons	1,366,661	15,734	71,446	618,390	661,091
Value	$9,332,299	$43,791	$540,617	$3,565,552	$5,182,339
Grease (lubricating, etc.)—					
Barrels of 50 gallons	202,439	23,875	19,659	88,085	70,820
Value	$1,394,130	$79,594	$158,885	$377,137	$778,514
Naphtha and gasoline—					
Barrels of 50 gallons	5,811,289	238,015	467,594	1,774,626	3,331,054
Value	$21,314,837	$926,063	$1,676,529	$6,402,492	$12,309,753
Paraffin wax—					
Barrels of 50 gallons	794,068	3,598	47,533	279,511	463,126
Value	$10,007,274	$38,919	$549,515	$3,017,004	$6,401,836
Sludge acid—					
Short tons	165,104	18,045	----	38,216	108,843
Value	$400,480	$25,829	----	$140,627	$234,024
Coke and black naphtha, value	$149,653	$10,008	$30,448	$23,481	$85,716
All other products, value	$14,475,669	$137,095	$1,592,872	$1,499,369	$11,246,333
Equipment:					
Stills—					
Heated by steam, number	282	14	32	112	124
Heated by superheated steam, number	15	----	1	4	10
Heated by fire, number	1,610	92	184	400	934
Agitators, number	374	47	52	120	155
Chilling houses for paraffin, number	67	1	8	48	10
Hydraulic or other presses, number	311	2	41	124	144
Storage tanks—					
Crude petroleum, number	304	43	20	131	110
Capacity in gallons	245,760,493	12,439,724	8,964,030	42,683,656	181,673,083
Refined petroleum, number	3,575	375	499	1,191	1,510
Capacity in gallons	576,458,825	49,410,383	84,888,435	110,111,758	332,047,749
Cooper shops	64	11	7	30	16
Tin shops	17	2	1	3	11
Power:					
Number of establishments reporting	94	17	12	42	23
Total horsepower	49,337	1,323	4,406	13,268	30,340
Owned—					
Engines—					
Steam—					
Number	1,072	25	140	311	596
Horsepower	43,480	1,048	4,172	9,689	28,571
Gas or gasoline—					
Number	57	1	5	46	5
Horsepower	2,659	10	139	1,740	170
Electric motors—					
Number	224	6	2	60	156
Horsepower	3,318	40	20	1,659	1,599
Other power, horsepower	330	75	75	180	----
Rented—					
Electric motors—					
Number	14	14	----	----	----
Horsepower	150	150	----	----	----

HISTORICAL AND DESCRIPTIVE.

Petroleum, known also by other names, such as rock oil, mineral oil, coal oil, or earth oil, is an oily liquid, varying in color from light straw through amber, red, and brown to black. Existing in the earth, it is obtained from either springs or wells. Petroleum is distributed widely, and its existence was known to the ancients. The aborigines were familiar with many localities in North America where it issued from the ground and spread out on the surface of the water in contiguous pools, creeks, and rivers. The oil spring of the Seneca Indians, located near what is now Cuba, N. Y., was one of the more celebrated of these springs, and the oil collected there was used for medicinal purposes.

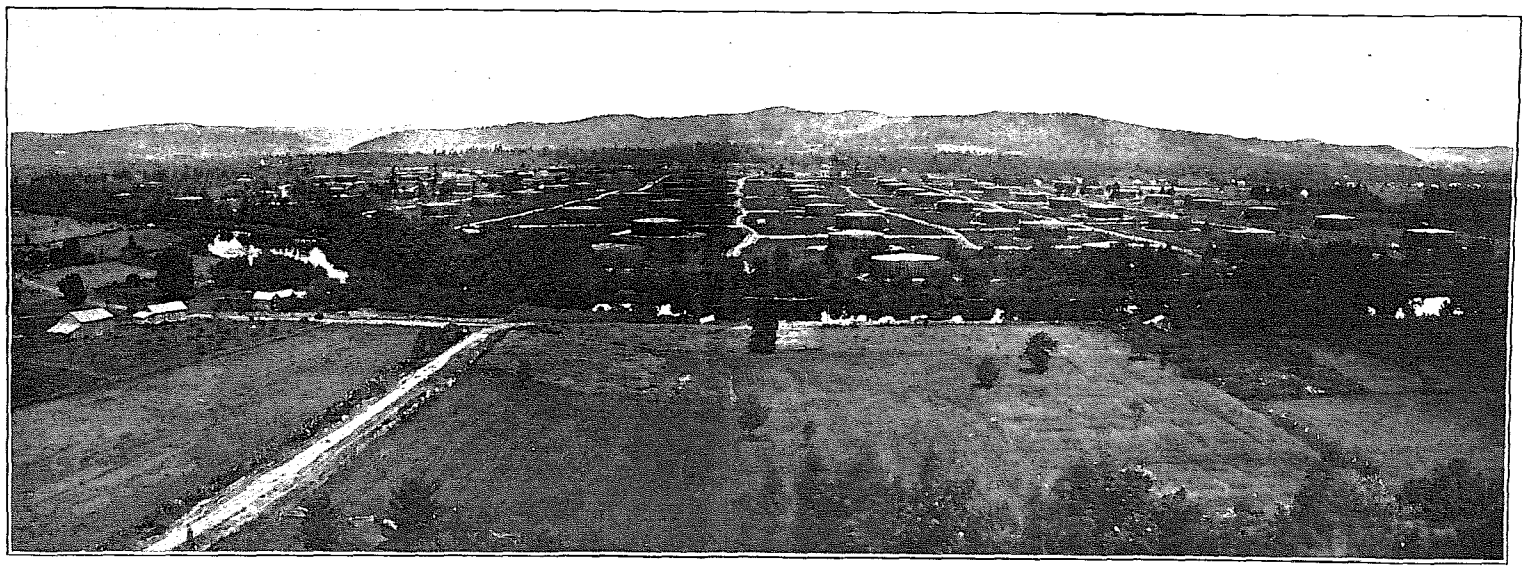
Although a natural product, petroleum is not a definite chemical compound. It consists of a mixture of various hydrocarbons from several different acyclic and cyclic series, and of hydrocarbon derivatives containing sulphur, or oxygen, or nitrogen, or other elements. These chemical substances have widely varying physical properties and appearances, differing in color, odor, volatility, viscosity, inflammability, specific gravity, boiling and freezing points, and in other particulars; hence mixtures of them in different proportions will appear quite unlike. Furthermore, the components in such mixtures are held together so loosely that they may be separated, more or less completely, by comparatively simple methods, such as filtration, and especially capillary filtration, through fuller's earth, kaolin, boneblack, or other finely divided and porous solids, or by fractional distillation. Therefore, considering the conditions which affect the natural material in different localities, it is not surprising that the varieties of petroleum obtained in Texas, California, and Ohio should differ in appearance and properties from each other and from the better known Pennsylvania petroleum; or that in Kansas petroleum may be obtained which is immediately suitable for use as an illuminant, while in West Virginia petroleum is found which is suitable for use as a lubricant without undergoing any preliminary treatment.

If the survey were extended to include the petroleum found in foreign countries, such as Canada, Russia, Burma, and elsewhere, additional variations might be noted, yet Mabery, who has exhaustively examined a large number of samples from widely different sources, says:[1] "Now, after these years of arduous labor, I have reached the conclusion that petroleum from whatever source is one and the same substance, capable of a simple definition—a mixture in variable proportions of a few series of hydrocarbons, the product of any particular field differing from that of any other field only in the proportion of these series and the members of the series." However, from a commercial standpoint, petroleum from different localities is regarded as different substances, and the products are referred to and considered from the standpoint of some predominating or characteristic constituent. Thus, Pennsylvania petroleum is classed as an oil with a paraffin base; Texas and California petroleum, as oils with an "asphalt" base; petroleum from the Lima field in Ohio, as a sulphur oil; and so on as the characteristics are developed.

Although petroleum as found in nature, and therefore styled crude petroleum, has in recent years come to be used extensively in locomotives and ships, and for metallurgical, manufacturing, and domestic purposes as a fuel, and although other uses have been found for it, such as oiling roads, coating piles, and exterminating insects, yet for the majority of purposes petroleum must be treated before use to adapt it to the special purpose to which it is to be applied, and this treatment constitutes the industry known as petroleum refining. The processes employed in petroleum refining are many in number and different in degree of complexity. The particular process used in any given case is determined by the character of the petroleum to be treated and the character of the products sought. In the case of the more complex processes a method of treatment suitable for a crude petroleum from one locality is poorly adapted or wholly unsuitable for the treatment of crude petroleum from another. The processes of refining may be roughly classified as follows: Treatment by settling to remove suspended matter and water; filtration; fractional distillation; destructive distillation; and, subsequent to or combined with the process of distillation, the treatment of the distillates, known as fractions, with acids or alkalies, or both, and sometimes with other chemicals; also, treatment by chilling, pressure, and filtration.

The cleaning of crude petroleum by settling is the process used in the case of heavy, viscid oils found in loose sand of great fineness, since the sand and water become mixed with the oil and are pumped up with it. An example of this method is found in the practice obtaining in the Kern River oil field of California, where great difficulty is experienced from sand. It is customary there to pump the oil into small excavations made in sandy soil as close to the well as possible. These holes, called "sumps," are originally of from 500 to 2,000 barrels capacity, but they rapidly become shallower from the deposits of detritus from the oil. From the sumps the oil flows by gravity to storage reservoirs, which are shallow excavations made in the soil and covered with light wooden roofs. These reservoirs are often of great size, and it is customary to carry in them as large a quantity of oil as possible, in order that the sand may settle and the water separate completely. During the summer months the oil is continually at a

[1] Journal American Chemical Society, 1906, vol. 28, page 417.



STORAGE TANKS FOR PETROLEUM.

high temperature and becomes clean by this simple treatment. During cooler weather, or whenever the reservoir purification is thought insufficient, the oil, before shipment, is passed through a small steel tank provided with steam coils, where it is heated for a sufficient time to remove these impurities. The degree of temperature, which is from 110° to 150° Fahrenheit, and the duration of time, which is usually only a few hours, are determined by the specific gravity of the oil and the amount of impurities it contains. According to Prutzman,[1] "The high degree of purity which is obtained by the use of these simple methods is quite astonishing. Even where the impurities originally amount to 50 per cent of the bulk of the crude oil, which is often the case, the oil finally shipped will not contain more than 2 per cent of foreign matter of all kinds, and the larger part of the fuel oil in the San Francisco market, at least, will be found to contain less than 1½ per cent of impurity." This treatment results in other advantages, for the gas with which the oil is charged as it comes from the well, and which affects its gravity and flash point, is also very largely removed. It is interesting to note that when oils, such as these heavy crude oils, are exposed in shallow pools to sunlight in hot climates the oil is so oxidized that its gravity is lowered while its viscosity is raised, and the oxidation may proceed so far as to convert the oil into a tarry mass. If the dissolved gases be removed from the oils and sunlight be excluded, the effects of high natural temperatures are not serious, and it thus becomes possible to store oil for considerable periods in such reservoirs. Although the oil has been distinctly improved by methods of purification, such as described, the product is not considered as refined oil in the Census classification and the establishment in which the operation is carried on is not included with refineries.

Filtration was resorted to for the purification and refining of petroleum, especially in preparing it for use in medicine, at a very early date. Doctor Hildreth in 1833 mentions[2] filtering petroleum through charcoal, by which process much of its "empyreumatic smell is destroyed and the oil greatly improved in quality and appearance." Since then a large number of different substances have been employed as filtering mediums to remove from crude petroleum all sediment and suspended matter, together with part of the color and odor. Since the development of refining by distillation, filtration for the removal of color and odor has been confined largely to the denser natural oils which are used for the production of lubricating oils and which may lose some of the qualities that especially fit them for this purpose, if subjected to the conditions which obtain in the process of distillation. Crude oils which contain lubricating oils, but owing to the presence of volatile portions are too fluid for direct use, are reduced to the desired consistency by partial evaporation, either by exposing them in shallow tanks to solar heat, or by driving off the more volatile portions in stills, or both, and they may be further cleansed and purified before or after concentration by filtration.

Partial distillation is employed in the production of reduced oils. This process requires the use of shallow wooden tanks on the bottom of which flat steam coils are placed; water is run into the tanks to a depth of from 8 to 10 inches, and a layer of oil 1 inch in depth is placed upon the water; the whole is then heated until the oil becomes very limpid, and this temperature is maintained until the desired specific gravity is reached. An advantage in this treatment, as in the method of settling described above, lies in the removal of every kind of dirt, especially the minute particles of grit which may have been held in suspension in the viscid oil, and if allowed to remain would seriously detract from the value of the reduced oil as a lubricant. Another method practiced in the manufacture of reduced oils consists in suspending sheets of loosely woven cloth vertically above troughs in a heated chamber, and through a perforated pipe spraying the crude oil upon the upper edge of these curtains. As the oil slowly descends the curtain it spreads out as a thin film, thus exposing a very large surface to the heated atmosphere of the chamber; and thereby the more volatile portions of the oil are rapidly driven off. At the same time the fiber acts as a filtering medium, retaining the sediment and other impurities of the crude oil, so that the surplus oil, as it drips from the lower border of the curtains into receiving troughs, is not only reduced and rendered more viscid but is also purified and cleansed.

The process of refining by fractional distillation depends primarily upon the fact that different liquids, when subjected to the same pressure, boil at different temperatures, from which it might be inferred that if a mixture of different liquids were heated gradually, each component of the mixture as it reached the temperature at which it boils would assume the state of a vapor and separate from the mixture. If only these simple conditions obtained, the separation of a liquid mixture into its individual components could be effected merely by heating the liquid to the successive boiling points of its components, and condensing and collecting the distillates. But the conditions are not so simple, for the separation of components of solutions by heat depends not only on their relative boiling points, but also on their relative vapor pressures, and vapor pressures change with the temperature. Further, the most complicated conditions arise where, as in the case of crude petroleum, the mixture consists of liquids which dissolve one another, that is, are miscible in each other, and the complexity increases with the increase in the number of components.

[1] Bulletin No. 32, California States Mining Bureau, page 56.
[2] American Journal of Science, vol. 24, series 1, page 63.

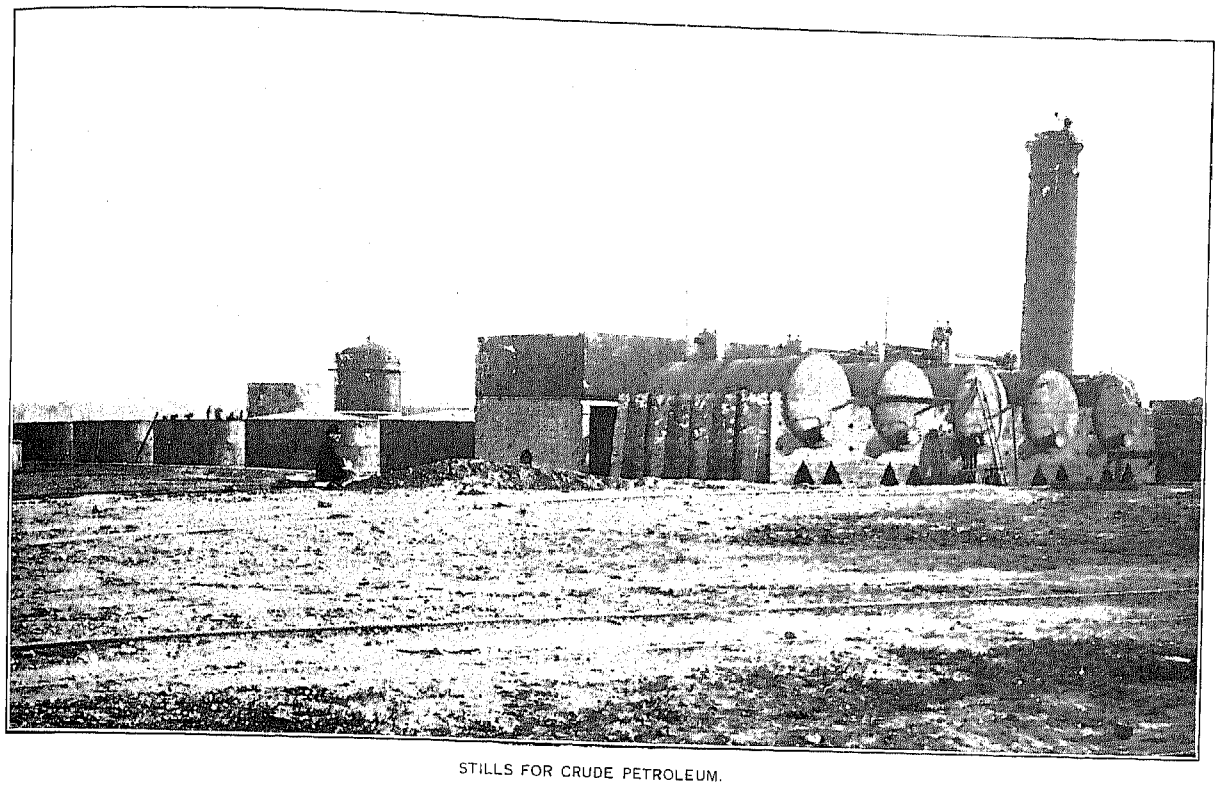
The case may be stated for a system of two miscible liquids as follows: Such a mixture on being heated is continually changed in composition during vaporization, and this brings about a change in the pressure and the composition of the vapor. If the two components have very different vapor pressures and their boiling points are correspondingly wide apart, the vapor pressure and boiling point of the mixture usually fall between those of the components, and under these circumstances the more volatile liquid goes over in the largest proportion in the first stages of the distillation, while the greater portion of the less volatile liquid remains behind. The separation is not, however, complete. The liquid mixture has been divided into portions, called fractions, but each fraction still contains some of each constituent. It has obeyed the law stated by Barker:[1] "Since at the same temperature the vapor pressure of a liquid is proportioned to its volatility, a mixture of two or more vapors when condensed will yield a liquid richer in the more volatile constituent." By repeating the distillation of the separate fractions and uniting those obtained between the same boiling point limits, a practically complete separation may eventually be effected. But if, on the other hand, the two components of the liquid taken as an example have vapor pressures and boiling points which lie near together, one of two other consequences may follow. The mixture behaves similarly to one composed of liquids not completely miscible, and the vapor pressure of the solution is greater than that of each of its components. In this case there must be a certain ratio between the two pure liquids at which the common vapor pressure will attain its highest value. This mixture will consequently have the lowest boiling point of any possible combination of these two substances, and it will, on distillation, behave like a pure substance with a constant boiling point and distill over, leaving in the still the substance which is in excess with respect to this boiling point mixture. On the other hand, the mixture of the two liquids may have a lower vapor pressure than that of either component. Such liquids must form, in definite proportions, that mixture which has the lowest vapor pressure and the highest boiling point of any possible mixture of these two substances, and on distilling the liquid, anything present, for example an excess of one of the components which is more volatile than this definite mixture, passes over first, leaving in the still the mixture with the highest boiling point, which behaves much like a single substance, and distills without separating into its components.

The distillation of crude petroleum is usually carried out in either cylindrical or "cheese box" stills. The size and the arrangement of these stills and the method of heating them vary with the character of oil to be treated and the products sought. The cylindrical still consists of a cylinder of boiler plate, 30 to 40 feet in length and 12 feet 6 inches to 14 feet in diameter, the lower half of which is usually of steel. The still is set horizontally in a furnace of brickwork, which is usually so constructed that the upper surface of the still is exposed to the air. Stills are often set in batteries of from two to ten for convenience in operation. The "cheese box" still has a body and a dome-shaped top made of boiler plate, and a double curved bottom made of steel plate. They may be 30 feet in diameter and 9 feet in height, and they are set vertically on a series of brick arches. The working charge of the cylindrical still is from 600 to 1,000 barrels, and of the cheese box still, 1,200 barrels.

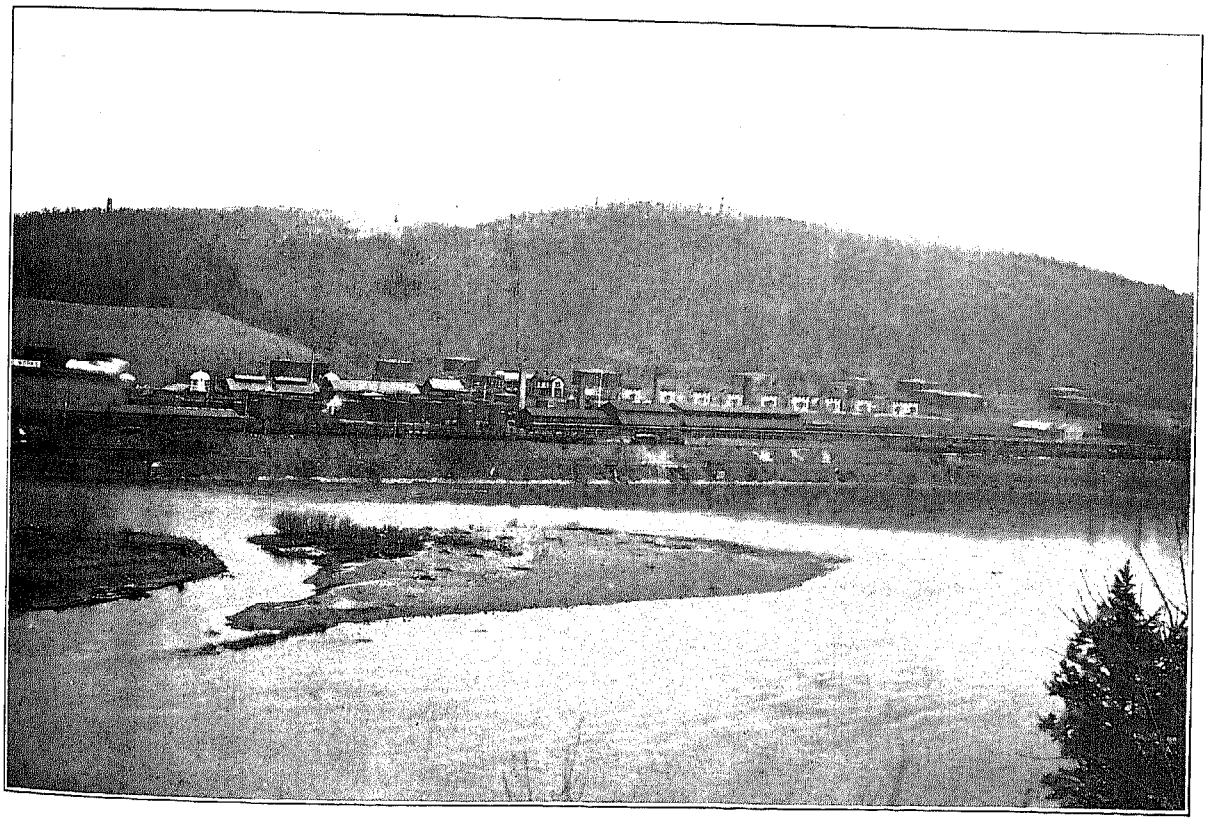
Either form of still may be heated by direct fires or by coils of steam pipes, either closed or perforated, which may be fitted into the stills to heat the oil, or by the injection of steam to facilitate, on the principle of partial pressures, the passing over of the distillates. Some stills are connected with an exhaust pump by which a vacuum may be maintained in them during distillation. The top of the still is usually provided with a dome into which the vapors rise and from which they pass to the condensers. The condensing apparatus consists primarily of long coils of pipe immersed in tanks through which cooling water flows. All the coils or lines are made to converge near the terminal so that they enter the receiving house within a few inches of each other. A trap is placed in the pipe near the end of each line for the purpose of leading off the gases or difficultly condensable vapors which are produced, and these are either collected for fuel or discharged into the atmosphere. The condensing pipes generally deliver the distillates into box-like receptacles, sometimes known as "sight boxes" because they have sides of plate glass through which the running of the distillate may be observed. Hydrometers, by which the density of the distillate may be noted, and thermometers, for determining its temperature, are immersed in the flowing liquid or in samples of the run which may be taken from time to time for testing. As the character of the distillate changes, the delivery pipes from the condensers are turned to different receptacles. The receptacles lead to storage tanks or reservoirs, sometimes styled "cut tanks."

In addition to the above stills there are in use what are known as tar stills, which are made of iron or steel and are cylinders 10 feet in diameter and 20 feet in length. They are set horizontally in brickwork in batteries of two and are heated by fire. They hold about 260 barrels, and are provided above with air condensers leading from a dome in the center of the top of each cylinder. The condensers are of 4-inch iron pipe coiled in three turns one above the other in a rectangle of about the length and width of the still. As the coil makes one complete turn, it is trapped to

[1] George F. Barker: Physics, 1892, page 318.



STILLS FOR CRUDE PETROLEUM.



BIRD'S-EYE VIEW OF ECLIPSE WORKS.

carry off the products which have condensed at that stage.

As stated, the process of distillation varies with the circumstances, but the operation may take place as follows: The oil is first allowed to stand in large tanks so that part of the water and sediment are removed before it is pumped to stills into which live steam is introduced. Distillation commences at once and the distillate is collected in a receptacle continuously until its specific gravity reaches 0.74 (60° B.). The condensers are now connected to another receptacle, and as the temperature rises and distillation proceeds the distillate is collected until its specific gravity reaches 0.81 (40° B.). The heavy oil which remains is often distilled with superheated steam for the production of lubricating oil. The first original distillate is redistilled by steam and separated, commonly, into five different fractions. The second original fraction may be subjected to a second distillation to drive off lighter oils, which are then added to the first original fraction. The third original fraction may be chilled so as to cause the paraffin present to crystallize. The semisolid mass of paraffin thus produced is then subjected to pressure to drive out the oil which is present. This oil is further subjected to the action of steam in a still to remove from it certain oils which possess a pungent and offensive odor. The distillates are then subjected to chemical treatment or to filtration, or to both if further refining be desired.

It was noted long ago in the making of coal gas that if the less volatile products from the distillation of the coal were allowed to condense and fall back into the hot retort, the liquid was decomposed into other substances, some of which were much more volatile than the original condensation product. This process of breaking up an organic liquid by heat is called "cracking." It is a process of destructive distillation and may be applied to many substances. It has long been applied to the treatment of petroleum, for by its use a larger portion of illuminants and oils of low boiling point may be obtained from a crude petroleum than is usually obtained by simple distillation only, since in the latter case a large per cent of the petroleum may remain as heavy oils or paraffins. In this process the operation of distillation is carried out as before, using fire, but when the second original fraction has been separated and collected, the fires are slackened and the distillation allowed to proceed slowly, in consequence of which the vapors of the heavy oil are repeatedly condensed upon the dome of the still and fall back upon the hot oil beneath, with the result that there is produced a large volume of gas, composed chiefly of marsh gas and hydrogen; a distillate of suitable specific gravity for the production of illuminating oil; and a heavy, tarry residue, called "residuum," which remains in the still. This residuum goes to the tar still, where, on further distillation by fire, there is collected at the first trap heavy distillate, at the second trap intermediate distillate, and at the third trap light distillate, while tar coke is left in the still. The first of the above distillates is wax bearing, and in the last part of its run this distillate is known as wax tailings; the third consists largely of illuminants, while the second distillate is of an intermediate character. All are joined to analogous materials passing through the refinery and are reworked by methods similar to those described above.

Oils that are to be subjected to chemical treatment to improve their color, or to remove components which might interfere with their use for particular purposes, are pumped from the cut tanks into the agitators. The latter are narrow upright cylinders with conical bottoms, generally lined with sheet lead and provided with an air blast descending from above and with outlets below for the spent chemicals and the treated oils. Agitators may hold 50,000 gallons of oil at one charge. The reagents usually employed are concentrated sulphuric acid and caustic soda or other alkalies. The sulphuric acid forms sulphonic acids, and addition and other compounds with the unsaturated hydrocarbons, through which they become soluble in water, and may be removed. At the same time other of the components of the oil are oxidized, so that, as a result of the reaction, when the oil is mixed with acid by means of the air blast, the mixture becomes thick and black and there is an evolution of sulphur dioxide. The mass is allowed to stand and thereby separates into layers of oil and spent or "sludge" acid. The latter is drawn off and the oil washed by agitation with water. It is then treated with an alkaline solution, by means of which not only any free sulphuric acid but also any acid salts or other bodies present may be neutralized. After the alkaline solution has settled and been drawn off, the oil is washed until all traces of alkali are eliminated, and then it is drawn off to settling or sunning tanks. In special cases it may now be again distilled to fraction it more completely, or it may be treated in a steam still to reduce it.

The quantity of sulphuric acid required in refining petroleum and the length of exposure to its action depends on the original purity of the distillate and the purity sought. Cracked oils require more acid than uncracked, and the Ohio oils require more than the Pennsylvania. Usually the amount of acid required increases with the density of the distillate. It is, as a rule, added in repeated doses until the desired result is obtained. The acid sludge is sometimes treated so as to regain the sulphuric acid for reuse; at other times it is used in the manufacture of fertilizers and for other purposes in chemical manufacture.

In 1905, 165,104 short tons of sludge acid, having a value of $400,480, or $2.43 per ton, were reported as having been sold from the refineries. The weight of sludge acid thus accounted for formed 78.1 per cent of

the total sulphuric acid used in refining in that year. In 1890 there were reported 33,911 tons of sludge acid used for fertilizers and chemicals, and 19,962 tons for recovered sulphuric acid, the total, 53,873 tons, constituting 56.1 per cent of the total sulphuric acid reported as used in refining petroleum at that census. In 1880 there were reported 22,163 tons of sludge acid used for fertilizers, and 21,159 tons for recovered sulphuric acid, the total, 43,322 tons, constituting 94.5 per cent of the total sulphuric acid reported as used in refining petroleum at that census. The alkali sludge has sometimes been heated to destroy the organic matter present and recover the alkali, but this is usually found unprofitable.

When sulphur is present in petroleum, it is difficult of removal, so that special treatment must be given oils, such as Lima oil, which are high in sulphur contents. Some refiners effect this by distilling the petroleum over scrap iron and treating the distillate first with an alkaline solution of lead oxide, and then with flowers of sulphur to remove the last traces of lead. Much the greater part, however, is distilled over copper oxide, the oxide being regained by burning off the sulphur.

According to Mabery,[1] "Probably 50 tons of sulphur daily is a conservative estimate of the amount extracted from Ohio oil and burned off into the atmosphere. It is claimed for this process that it is capable of removing the sulphur to two one-hundredths of 1 per cent, which is probably correct." In addition to the chemicals mentioned, others are sometimes used, among which are chromic acid or bichromate of potash and sulphuric acid, employed to oxidize the acrid and objectionable components; nitronaphthalene, added to the oil prepared for sale to mask the phenomenon of fluorescence, or to debloom the oil; and many others mentioned in the patents on petroleum refining.

The classification of petroleum products is a matter of difficulty because the same name has at various times been given to different substances, some of which are not products of petroleum, and because the same material has been known by different names. The different products may, to some degree, be differentiated by their boiling points, specific gravities, and fire tests. Yet again there is confusion from the use, for liquids lighter than water, of the Baumé hydrometer, which has a purely arbitrary scale, with which to gauge the densities of the oils, instead of one which would measure their real specific gravities directly, so that a 60° oil on the Baumé scale is one whose real specific gravity is 0.745, while a 48° B. oil is one whose real specific gravity is 0.794; in other words, the higher the number on the Baumé scale, the lower is the real specific gravity and the lighter the oil. Likewise, the fire test, or test of the behavior of the oil on exposure to a naked flame or source of ignition, covers both the flashing point test, for determining the lowest temperature at which the oil gives off vapors which form combustible and explosive mixtures with air, and the burning point test, for determining the lowest temperature at which the body of oil will take fire and continue to burn. It is greatly to be regretted that this confusion exists in the literature on the subject, and particularly in the statute books, as the flashing point test is the one by which the community is protected from accidental explosions and fires in the handling and use of illuminating oils.

With this introductory explanation, it may be stated that the term "naphtha and gasoline" embraces pentane, boiling point 100.4° F., real specific gravity 0.625, which is used as a standard of light in photometric work; petroleum ether, boiling point 104° F. to 158° F., specific gravity 0.65 to 0.66 or 85° to 80° B., which is sometimes known as Sherwood oil, and is used as a solvent for caoutchouc and fatty oils, and for carburetting air in gas machines; 76° gasoline, boiling point 158° F. to 194° F., specific gravity 0.66 to 0.69 or 80° to 75° B., known also as 680 spirit, motor spirit, petrol, carburine, and boulevard gas fluid, and used in naphtha lamps and internal combustion engines, in the extraction of oil from seeds and fat from garbage and wool, and in carburetting water gas; naphtha, boiling point 177° F. to 230° F., specific gravity 0.69 to 0.70 or 76° to 70° B., known also as Danforth's oil, ordinary spirit (when in the condition of untreated distillate), deodorized spirit (when purified), and city naphtha, and used as petrol in motor cars, for burning in vapor stoves and street lamps, as a solvent for resins in making varnishes, and in the manufacture of oilcloths; stove naphtha, specific gravity 0.70 or 70.4° B.; ligroïn, boiling point 176° F. to 248° F., specific gravity 0.71 to 0.73 or 67° to 62° B., used as a solvent in the chemical laboratory and in pharmacy and for burning in sponge lamps; benzine (deodorized), boiling point 248° F. to 302° F., specific gravity 0.73 to 0.75 or 65° to 57° B., used as a substitute for turpentine for cleaning printers' type, and for dyers', scourers', and painters' uses. In the refinery all of the above mentioned fractions may be included in the substances known as A-naphtha, specific gravity 0.74 or 64° to 60° B.; B-naphtha, specific gravity 0.72 or 68° to 64° B.; and C-naphtha, specific gravity 0.70 or 80° to 68° B. All petroleum distillates having a specific gravity above 60° B. may be styled "naphtha and gasoline." Although engine distillates which are a cut between "naphtha and gasoline" and kerosene, may be classed with the former, the lightest engine distillates, which run well up in the sixties in gravity, are prepared for small engines, while the heaviest are intended to replace kerosene in kerosene engines. As a rule they are

[1] Journal of the American Chemical Society, 1906, vol. 28, page 432.

not as carefully purified as gasolines and kerosenes of the same gravity and differ, in the lower members, from kerosene in that no attention is paid to the flashing point.

The distillate collected between 60° B. and 40° B., or specific gravity 0.744 to 0.829, is crude illuminating oil. The refined illuminating oils are known by a large number of names, the most common general name being kerosene. The oils are graded by their color, their flashing point tests, their burning point tests, and their specific gravities. Water white oil of 120° F. flashing point test, 150° F. burning point test, and 48° B. gravity is standard, but there are many other gravities of water white oil. The Quartermaster's Department of the Army has specified 135° F. flashing point as the minimum for oil supplied to that department. Other grades, by color, are prime white, having a faint yellow color, and standard white, having a pronounced yellow color. Water white oil of gravity 45.5° B. and 175° F. burning point is frequently sold as headlight oil for use in locomotives. Water white oil of 36° to 38° B., and 300° F. burning point is known as mineral sperm oil, mineral seal oil, mineral colza oil, coach oil, and 300° oil, and is used as an illuminant in railway coaches and lighthouses, and for other purposes where readily ignitible oils are objectionable. Such an oil produced from wax oil, when pressed, and not lighter than 34° B., is used in Pennsylvania in compounding miners' lamp oil. An oil having a specific gravity of from 0.85 to 0.86 and a flashing point above 100° F. is known as gas oil. Stove oil is generally a cut from the crude still following the kerosene.

The lubricating oils vary so greatly as to be beyond description within reasonable limits. All should have high burning points, and a natural lubricating oil to be of real value must not ignite under a temperature of 325° F. The lightest of the lubricating oils, varying in gravity from 32° to 38° B., are known as neutral oils, or when further purified by filtration through boneblack or fuller's earth, as they usually are, as neutral filtered oils. Heavier lubricating oils are styled "spindle oil" and "cylinder oil." The most important characteristics which distinguish these oils are high burning point, and viscosity, and low cold test. Cylinder oils are obtained by distilling the heavy oils, from which the naphthas and illuminating oils have been removed, with superheated steam, taking care that no cracking takes place. Or they may be produced by distillation in a vacuum. Paraffin lubricating oils are obtained by chilling the first distillate from the tar stills or other wax bearing distillates, these being chilled in the chilling house by cold brine from an ammonia ice machine. The chilled mass is pressed to separate it into paraffin and oil, and this oil is then redistilled and cut into several fractions. The common cuts for paraffin oil are one of 29° to 30° B., and a heavy cut of 23° to 26° B. To give the oils higher burning points and viscosities, they are cut from one-half to one degree higher than wanted and then reduced in a reducing still by means of steam and fuel.

Besides the various oils, semisolid products, represented by vaseline, and solids, such as paraffin and petroleum coke, are obtained in petroleum refining. Vaseline is obtained by filtering heavy cylinder stock through boneblack filters until the required color is obtained; the first runnings from the filters, which are sufficiently light in color, may be used for vaseline, and the darker part used as filtered cylinder stock. To secure the necessary consistency and melting point, pure paraffin is melted and added to the filtered material. Rod wax obtained from the tubes and rods of pumping wells and the salvy residues from oil tanks and pipe lines, which is known in the industry as B. S., are employed in the manufacture of these semisolid petroleum products. They are used directly as ointments or employed with drugs in the manufacture of ointments and salves, and are styled in the United States Pharmacopœia *Petrolatum molle*, or soft petrolatum, the requirement being that they have a melting point of from 104° to 113° F. If the rod wax be pressed, it yields a solid with a low melting point and a salvy half-paraffin nature, which, either directly or when mixed with chicle or balata gum, is used as chewing gum. Paraffin, obtained from the chilling and pressing of the wax bearing distillates, preferably distilled at high temperatures to insure crystallization, is generally manufactured in three varieties, with melting points of 125° F., 128° F., and 135° F., known as C., B., and A. paraffin, respectively. The *Petrolatum spissum*, or hard petrolatum, of the United States Pharmacopœia, should have a melting point of from 113° to 125° F. Thus petroleum paraffin stands next in the order of petroleum products as classified by the melting points. The paraffin is purified by chemical treatment like that for the other distillates, by filtration to remove color, by recrystallization from solution in benzine, and by sweating. This last is done by chilling it in cakes in shallow trays having wire-mesh bottoms. These are stacked in rooms, which are gradually heated. The paraffin, having the lowest melting point, becomes liquid, drips out, and is collected; with another increase in temperature and change of receivers the paraffin of the next higher melting point is obtained, and the operation is thus continued until the desired degree of separation is effected.

Paraffin is used for many purposes in the arts. The harder varieties are used largely in the manufacture of candles, about 5 per cent of stearic acid being added to prevent the candle from softening and bending. They are used also for finishing calicoes and woven goods and in laundry work to produce a luster. The softer varieties are used for coating jellies and fruits in preserving jars, for the preparation of translucent and waterproof paper, for waterproofing cloth, for mixing with stearic

acid and wax in candle making, for impregnating the wood of Swedish matches, and as the absorbent in the process of enfleurage or extraction of the perfume from flowers.

Residual pitches are obtained in the distillation of the "asphaltic" petroleum of California, the "semiasphaltic" petroleum of Texas, and of some paraffin petroleum. The residues from California petroleum have been used to a considerable extent in the paving industry and are generally known as "D" grade asphalt or by some special trade designation or brand. According to Richardson[1] this "D" grade asphalt, when properly made, contains not over 10 per cent of fixed carbon, while the asphalt from Texas oil contains a higher percentage of this constituent. The more liquid portions of these residuums are used in compounding sheet asphalt, in which they constitute from 12 to 50 per cent of the composition. For this purpose, California oil should be from 10° to 13° B.; Texas oil, 14° to 16° B.; and Eastern oil, 18° to 22° B.; and all should have a flashing point above 350° F. to be suitable for use.

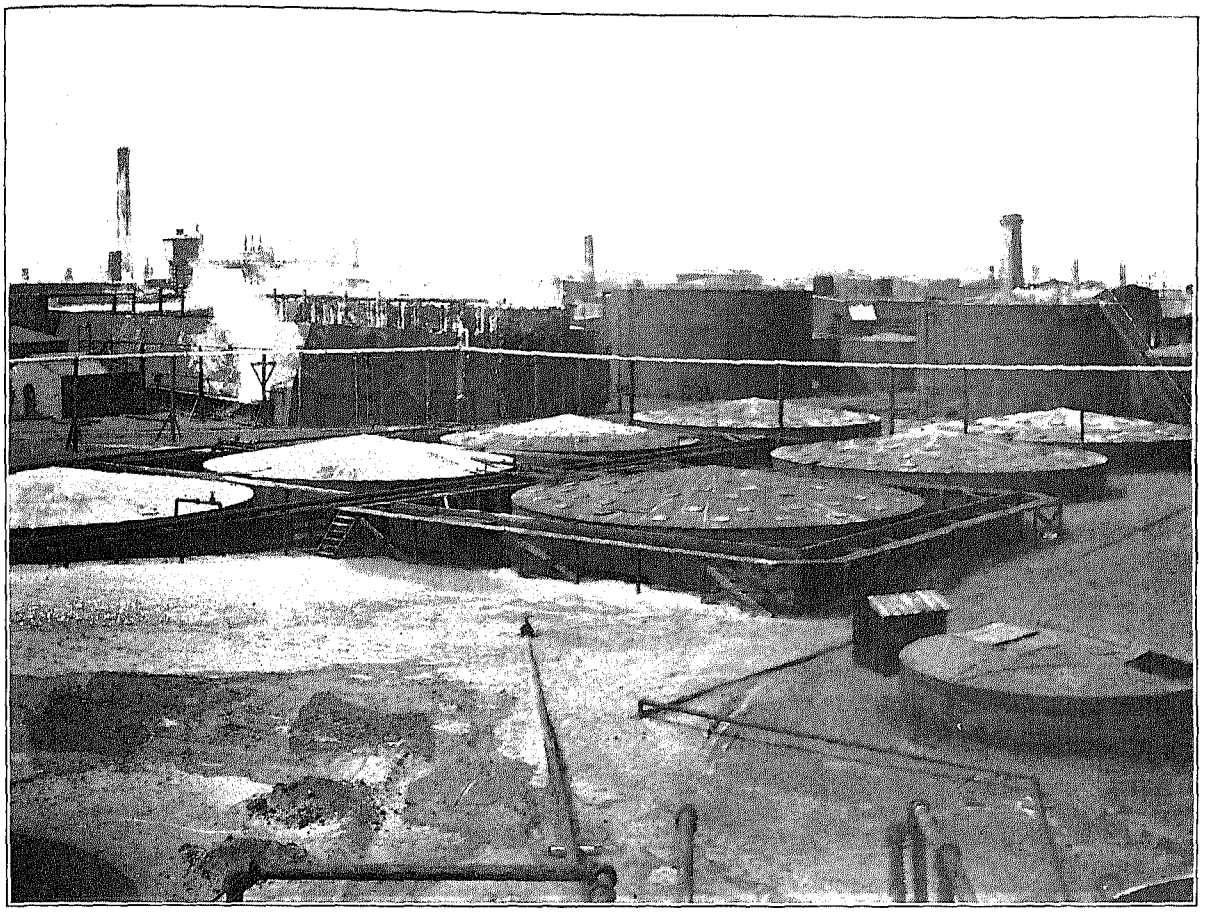
Other petroleum products used in the paving industry are Pittsburg flux, produced by heating a gallon of ordinary Pennsylvania petroleum residuum with about 1 pound of sulphur; Ventura flux, made by treatment of the California residuum in a similar manner; byerlyte, formed by oxidizing Pennsylvania residuum by sucking air through it, Byerly of Cleveland having found that oxygen, like sulphur, effected a condensation of the residuum; and hydroline B., produced by blowing air through the "asphaltic" residuum from Texas petroleum. These substances are prepared for use as fluxes for native asphalt. By blowing the crude oil with air similar oxidation and inspissation takes place. If the oil be warmed at the start, the oxidation not only maintains the temperature but causes it to rise to as high as 900° F. Water vapor is evolved, though but little, if any, of the more volatile components of the oil are driven off. The blown residues thus formed are used for waterproofing, for paints, for rubber substitutes, and for use in the arts. Residuums are used in oiling dirt roads. Petroleum coke, which is the porous, brilliant black solid left in the tar stills, is used in the manufacture of electric light carbons.

Greases are semisolid to solid products used in lubrication. They are usually made by mixing a lime soap with a petroleum distillate. A rosin-lime soap and mineral oil produces axle grease or set grease, and a mixture of lime soap made from horse fat or cottonseed oil with mineral oil is styled "engine grease." Both may be mixed with lead oxide, mica, soapstone, or graphite. Wax tailings are used on the rolls in iron and tin-plate mills under the name of roll grease. Compounded oils are produced by mixing mineral oils with animal oils, such as neat's-foot, lard, tallow, sperm, and whale, or vegetable oils, such as rape-seed, olive, or palm, with soaps, such as lead and aluminum soap, and with solids, such as graphite, mica, and soapstone. A very common oil, known as mineral castor oil, is made by compounding an aluminum soap with petroleum distillate. The number of mixtures possible is well-nigh infinite, and a very large number of these have been made, offered in commerce, and used.

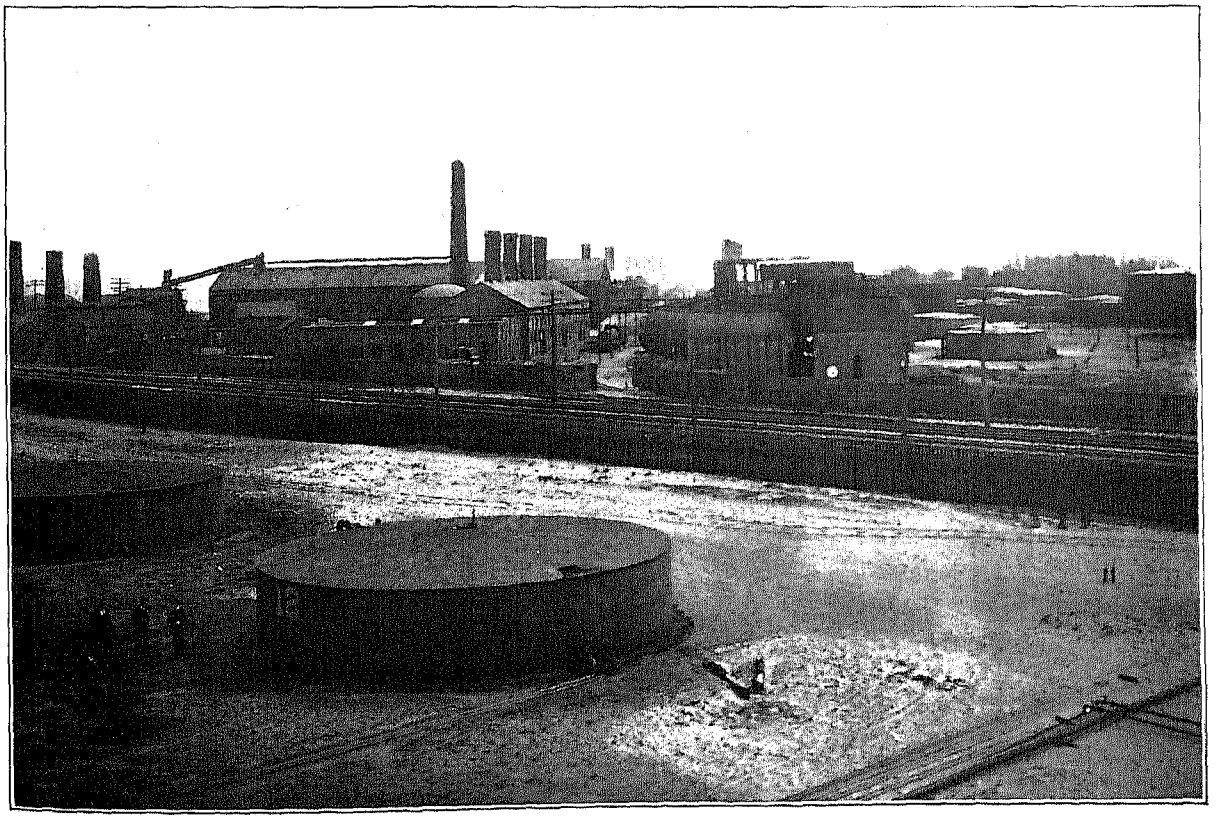
From the description here given of the petroleum products and from the consideration of the brief discussion of the laws which govern the behavior of miscible liquids when subjected to distillation, as previously set forth, it is apparent that the petroleum distillates offered in commerce are not definite chemical compounds, or even definitely compounded and constant mixtures. Although, by the use of the hydrometer and thermometer, fractions may be obtained having within limits similar specific gravities and boiling points, yet it does not follow that two distillates possessing these characteristics are otherwise similar, and observation of such distillates from different localities shows them to be different. It follows then that the general trade names only roughly designate the different distillates, and that a desired distillate must be carefully described in specifications by its physical and chemical properties. It is evident too that the process of refining requires much distilling and redistilling, with compounding of the distillates between redistillations, to obtain the maximum quantity of a desired product from the crude petroleum, and that these processes will vary in kind and number with the particular crude petroleum treated and as to whether or not cracking is resorted to. When there is added to these the employment of fire, or low-pressure steam, or high-pressure steam, or a vacuum in the processes of distillation and the variations in chemical treatment and filtration, it is apparent that no general description of the process of petroleum refining can set forth the operations of the different individual factories except in a very broad way.

The transportation and storage of petroleum products, and more especially of the lighter distillates, are of great public concern, since they have frequently given rise to accidents, owing to the fact that they freely give off, at the lowest natural temperatures, volatile inflammable vapors which form explosive mixtures with air. The liquid distillates are transported on a large commercial scale, in bulk, in pipe lines, tank cars, and tank ships, to distributing points, from which they are delivered in tank wagons, barrels, and cans to small consumers. Probably the larger part of all the lighter distillates produced are distributed in tank cars, which consist of cylindrical steel tanks mounted on their sides on platform cars. They vary in size, but are frequently 25 feet long by 6 feet in diameter and carry about 8,000 gallons of distillate. They are provided on the upper side with a covered

[1] The Modern Asphalt Pavement, 1905, page 253.



REFINERY, WHITING, INDIANA.



REFINERY, WHITING, INDIANA.

manhole, through which they are filled, and a safety valve to diminish the liability to explosion in case of fire. For shipment abroad, oil is put in rectangular tin cans holding 5 gallons each, and two such cans are packed in a wooden case. As examples of the hazard attending the transportation of petroleum products, there may be cited the explosion at Rochester, N. Y., December 21, 1887, following leakage from a pipe line across that city, and the fire and explosion at the Sheraden Yard, Pittsburg, Pa., May 12, 1902, following the collision of other cars with a tank car in making up a train. The liquid distillates are generally stored in steel tanks above ground. These should be provided with safety valves or screened ventilators and should be surrounded by screen walls of such construction and height, or should be partly sunk in an excavation or pit, in such manner that the inclosure will hold all of the liquid contained in the tank and prevent its escape in case of fire. These tanks above ground are frequently struck by lightning. A safer method of storage is in underground tanks, and only such tanks should be permitted in the midst of populated districts. Yet in these cases special precautions should be taken in construction and maintenance to prevent corrosion and leakage, as the escape of these volatile inflammable liquids into sewers, wells, and cellars may lead to very serious disasters.

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APPENDIX A.

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APPENDIX B.

DIGEST[1] OF PATENTS RELATING TO PETROLEUM REFINING.

This digest covers the patents included in the subclasses named in Class 196, Mineral Oils, of the United States Patent Office classification.

Some of the patents in these categories are quite foreign to the subject under consideration and many but indirectly related to it. On account of the form which discussions of patent issues often take, it has been thought better, however, to include these latter patents. The aim in making the digest has been to give such a sketch as will indicate the nature of the invention and what is claimed by the inventor, this generally being done by an actual abstract from or paraphrase of the words of the letters patent; but no responsibility is assumed for the opinions, theories, or claims thus set forth. Other related patents may have been granted which do not appear in this digest, because they are not embraced in the subclasses enumerated. It is suggested that such patents may be found in the classes relating to illuminating gas, wood distillation, coke, and similar topics.

CLASS 196.—MINERAL OILS.

SUBCLASS 1.—APPARATUS.

113,023—March 28, 1871. BENJAMIN CRAWFORD. *Improvement in apparatus for purifying coal oil.*

Claims the treatment of explosive burning fluids to a hot water bath, by means substantially as described.

114,293—May 2, 1871. SAMUEL A. HILL AND CHARLES F. THUMM. *Improvement in distilling hydrocarbon oils.*

This invention consists in preventing the explosion of stills used for distilling hydrocarbon oils where hot oil is transferred from one still to another in the process of distilling it, by placing in the still which is to receive the hot hydrocarbon oil a small quantity of cold oil, which is heated to the evolving point prior to its receiving the hot oil, or by placing a quantity of oil in the still to which is to be transferred the hot oil and arranging the pipes which convey the oil from one still to the other so that the hot oil will enter the still at a point which is below the surface of the cold oil, or by charging the still which is to receive the hot oil with carbonic acid gas or its equivalent prior to charging it with the hot oil, the whole being for the purpose of expelling the air from the still prior to transferring hot oil into it.

156,600—August 21, 1874. JULIUS SCHUBERT. *Improvement in stills for refining oils.*

The invention relates to modes of eliminating impurities from natural oils with hot water, and consists in the use of a hot water coil in its purifier.

240,983—May 3, 1881. GEORGE H. PERKINS. *Apparatus for cooling and drying the air blast employed in the process of cooling and refining oil.*

Heretofore the process of agitating oil for purifying purposes has consisted, essentially, of the following steps, viz, warm distillate or oil from the still is mixed with cold water in an agitator. The mixed mass is agitated by means of a blast of air forced through it. The water is then drawn off from the bottom of the agitator and the cooled oil is dried or freed from moisture, as well as from tar, by the addition of sulphuric acid and by agitation together therewith, by means of a blast of air forced into and through the mixture in the agitator. By the above treatment the water and tar have been caused to separate from the oil and to fall to the bottom of the agitator, at which point they are drawn off. In the above operation, however, the temperature of the oil is gradually raised by reason of the increase of temperature of the air blast, due to the force and velocity with which it is forced into the agitator and by reason of the action of the sulphuric acid upon the water or moisture in said air blast, with the result that the separation of tar from the oil is rendered more slow and incomplete as the temperature of said mass increases.

This invention consists in providing an apparatus for cooling and drying the air blast employed in connection with oil agitators; and the inventor claims—

An apparatus for cooling and purifying oil, which consists in a vessel or agitator for containing oil, an air blower, an air blast pipe extending from said blower into a bath of sulphuric acid contained in an air-tight tank, an air blast pipe extending from the top of said acid tank to a point within said agitator in proximity to the bottom thereof, and a water jacket surrounding said last-named blast pipe and adapted to contain cold water.

240,937—May 3, 1881. WILLIAM G. WARDEN. *Apparatus for cooling and drying the air blast employed in the process of cooling and refining oil.*

Claims an apparatus for cooling and purifying oil, which consists in a vessel or agitator for containing oil, an air blower, an air blast pipe extending from said blower to a point within said agitator in proximity to the bottom thereof, and a water jacket surrounding said blast pipe and adapted to contain cold water.

305,182—September 16, 1884. HALVOR HALVORSON. *Apparatus for distributing crude petroleum.*

Claims an apparatus for dividing crude petroleum, comprising a plate or part having an upper inclined separating surface and a lower inclined collecting surface, which surfaces are continuous, means for delivering the oil to be separated to the upper part of the separating surface, and means for collecting the primary and secondary oils separately as they drip off, all arranged to operate.

306,837—October 21, 1884. JOHN S. KLEIN. *Device for heating oil.*

This invention has relation to improvements in devices for heating petroleum, and it consists in the novel arrangement of the same, whereby the oil is carried from the tank to a heating drum, where it is heated and again returned to the tank.

339,201—April 6, 1886. JOSEF MERZ. *Apparatus for making extracts.*

This invention relates to improvements in apparatus for extracting from substances their fatty and other constituents, such as oils, sulphur, coloring matter, and in general all such constituents as are soluble in volatile solvents, such as some of the hydrocarbons, bisulphide of carbon, alcohol, or ether, and it consists in a reservoir, an extraction chamber, a siphon regulator, a boiler, and a condenser.

481,392—August 23, 1892. JACOB P. ENGLE. *Separation of waste products of petroleum distillation.*

Claims the process of separating the heavy oil arising from petroleum distillation from the water with which it is mixed, consisting, essentially, in imparting to the material a rubbing action to break up the globules and separate the water from the oil.

680,639—August 13, 1901. GEORGE FITZHUGH CARTER. *Oil purifier.*

Claims an oil purifier comprising a storage tank, a heating drum including a cylindrical body portion and a central vertical stack, a coil in the body portion, a pipe leading from the lower end of the tank to the lower end of the coil, a pipe leading from the upper end of the coil through the stack and connected to the upper end of the tank, a burner in the body below the coil, and a pipe connected with the pipe passed through the stack at a point above the stack and leading downwardly and vertically to the burner.

SUBCLASS 2.—REDUCING GRAVITY.

42,121—March 29, 1864. ALLAN GREIG AND JAMES SMITH. *Improvement in apparatus for separating gas from petroleum.*

Petroleum, on being taken from the wells, contains a large quantity of gas, which, when separated from the oil, can be used for fuel and also for the purpose of illumination; and furthermore, by expelling the gas the inflammability of the oil and the danger of explosions consequent upon this inflammability are considerably reduced.

By the apparatus which forms the subject of this invention the gas is expelled from the oil by the action of a current of air forced in by a fan blower or any other convenient means, and by the action of an air pump it is stored up in a suitable receiver, from which it may be conducted through suitable pipes to the place or places of consumption.

46,794—March 14, 1865. JOEL GREEN. *Improved apparatus for deodorizing petroleum, benzole, etc.*

This invention consists in the employment of an apparatus for deodorizing or removing the gas contained in the oil in vacuo, in such a manner that the oil is properly agitated to free it of the gas and is properly drawn off by a pump, and at the same time wasteful expenditure from conversion of the oil into gas by too high a temperature is prevented by retaining said gas in the apparatus till the excess is again condensed.

[1] Copies of these patents may be obtained on application to the United States Commissioner of Patents, Washington, D. C., at a cost of 5 cents each.

52,477—February 6, 1866. NORMAN W. WHEELER. *Improved method of relieving liquids of gases.*

The essence of this invention consists in so combining a liquid trap with the discharge pipe of a force pump or a vessel containing liquid and gas that that part of the gas or air not in intimate combination with the liquid will be set free automatically.

54,917—May 22, 1866. JOHN JOHNSON. *Improvement in collecting the light oils from oil wells.*

Claims the separating and gathering at the wells a new article of commerce, viz, the light condensable vapors which rise with petroleum, and which may be pumped off under any suitable seal and condensed, and,

Volatilizing and condensing the condensable products from petroleum at the wells by forcing air or gases through petroleum as carriers of the light products.

71,619—December 3, 1867. FLEURY HUOT. *Improved mode of treating petroleum to remove the more volatile portions.*

Claims subjecting petroleum and other oils to the action of air while such oil is in a finely comminuted or atomic condition, as and for the purposes set forth.

81,654—September 1, 1868. ROBERT G. LOFTUS. *Improved process of treating petroleum to remove the more volatile portions.*

Claims the separation of the petroleum into fine streams, and causing the same to pass through the atmosphere, so as to enable the latter to vaporize and dissipate the inflammable elements thereof.

82,083—September 15, 1868. CALVIN CARPENTER, JR. *Improved lubricating material.*

This invention relates to a lubricating material which is produced by putting crude petroleum in an open tank or cistern, setting fire to it, and allowing it to burn until all the light constituents of the petroleum are consumed and a residuum is obtained of superior lubricating properties.

The separation of the light constituents of the crude petroleum from its heavy parts being facilitated by floating the crude oil on water and passing a current of air or stream through it from below.

89,998—May 11, 1869. ALBERT H. HOOK. *Improved apparatus for freeing petroleum and other liquids from gas.*

Consists of a vertical cylinder containing a series of wire gauge diaphragms upon which the petroleum falls, while by means of a fan air is sucked up through the falling oil.

140,801—July 15, 1873. SAMUEL VAN SYCKEL. *Improvement in refining petroleum.*

In pumping oil wells it has been found that a gas exists in the oil as it comes from the well, which becomes free as soon as the oil is exposed to the atmosphere, and passing off is, on account of its highly explosive character, a source of great danger, but which, if collected and conveyed to the fire of the pumping engine, may be utilized as fuel, with a consequent saving in that item of expenditure and also with a total avoidance of the danger which ordinarily results from the escape of this gas into the atmosphere. It is also well known that in the distillation of crude petroleum a portion of the lighter vapors give, when distilled, a product of comparatively small commercial value, which, according to its specific gravity, is variously known as naphtha, gasoline, benzine, etc. These products, if they could be separated from the oil at the wells, could be in many cases used as fuel with great advantage. It is sought by this invention to draw off such gases and lighter vapors from the oil at any suitable point between the well and the tank and conduct them to the engine furnace or to any other desired fire, where, being used as fuel, they will be usefully employed, with a consequent saving of expense.

147,783—February 24, 1874. GEORGE W. MYERS. *Improvement in apparatus for purifying oils.*

This invention has for its object removing the dangerous and explosive gases from refined petroleum oil by forcing a strong current of heated air through the said oil when spread into a thin sheet or spray, thereby increasing its illuminating qualities while rendering it safe. The invention consists of the combination of the fan nozzle, apron, screen or screens, inlet pipes, and outlet pipes with each other and with the tank, and in the combination of the air tank and the coil of steam pipe with the fan nozzle, apron, screen, or screens, inlet pipes and outlet pipes of the tank.

150,614—May 5, 1874. JACOB REESE. *Improvement in treating refined petroleum oils.*

Claims subjecting the distilled and refined illuminating petroleum oils of commerce to the action of a vacuum, or partial vacuum, when not subjected to the action of artificial heat, and,

Recharging or resaturating the oil, after being subjected to the action of a vacuum, or partial vacuum, with any suitable nonexplosive gas or vapor.

169,189—October 26, 1875. WILLIAM C. PARKER. *Improvement in apparatus for reducing crude oil.*

This invention relates to means for making lubricating oil for machinery and other purposes, and the invention consists in an apparatus of novel construction whereby crude oil can be economically reduced without a process of distillation.

175,014—March 21, 1876. WILLIAM H. BIRGE. *Improvement in apparatus for increasing the density of oils, etc.*

This invention relates to means for increasing the specific gravity or density of crude hydrocarbons, by the evaporation of a portion of the lighter constituents of the fluid in its passage from a reservoir to a tank or other receptacle.

182,625—September 26, 1876. GEORGE ALLEN. *Improvement in apparatus for treating petroleum.*

This invention relates to apparatus in which the oil is drawn from elevated troughs by capillary attraction, and conducted by means of muslin or other fibrous sheets to a pan or oil receptacle below, the oil in its passage to the said pan being subjected to the action of currents of heated air caused by suitable heating apparatus located in or near to the pan.

211,055—December 17, 1878. DAVENPORT ROGERS. *Improvement in apparatus for separating refined petroleum into oils of different grades and fire tests.*

Claims a steam heater or drum, its contained coil of oil supply pipe, separator cylinder, a spiral perforated flange and condenser all combined as shown and described, and constituting an apparatus for separating refined petroleum or distillates into oils of different specific gravities and fire tests, as specified.

SUBCLASS 3.—STILLS.

4,008—April 22, 1845. WM. T. CLOUGH. *Manufacture of a useful oil.*

Claims the process of distilling rosin or the residues from rosin gas works and the separation of the oily distillate from the acid distillate which is produced.

16,642—September 2, 1856. CUMMINGS CHERRY. *Improvement in apparatus for purifying oil obtained from mineral coal.*

Claims the arrangement of horizontal retorts, as combined with copper heads of the rectifying chamber steam conduits to the oil boiler and agitating apparatus.

27,768—April 10, 1860. LUTHER ATWOOD. *Improvement in apparatus for distillation of coal oils.*

Claims a volatile oil still capable of being heated at the sides, and constructed with a removable lower section consisting of the bottom and a short section of the sides.

29,218—July 17, 1860. BENJAMIN GARVEY. *Improvement in distillation of coal oil.*

This invention consists in using compressed air to support combustion, so that the gaseous products may be held under compression until so much of their heat has been utilized, the amount of such utilization depending upon the pressure under which they are generated, that, on being allowed to expand, they will be of about the same temperature and in about the same state of elasticity as the surrounding atmosphere.

37,709—February 17, 1863. JOHN D. SMEDLEY. *Improvement in oil stills.*

Claims the use of a large pipe in combination with a small horizontal connecting tube, in any way, by means of which the fluid in the pipe, being kept constantly cool and free from agitation from the still, the quantity of liquid in the still is always correctly indicated.

44,137—September 6, 1864; reissue 1,989—June 13, 1865. WILLIAM ARCHER. *Improvement in distilling hydrocarbon oils.*

Claims the continuous and fractional distillation and separation of hydrocarbon and other oils and volatile substances by the direct application of superheated steam or hot air to the surface of a flowing sheet, column, or shower of the substance to be distilled in the manner described or any modification thereof by which the same result may be accomplished.

49,689—August 29, 1865. JOHN IVES VAUGHAN. *Improved apparatus for the continuous distillation of petroleum, etc.*

Claims the treatment of resins and resinous substances by continued or connected operations, whereby the spirit is distilled from the crude substances and the residual resin volatilized or distilled into a product which becomes solid at the ordinary temperature of the atmosphere without packing or cooling the resins between the operations.

50,935—November 14, 1865. JAMES J. JOHNSTON. *Improved apparatus for evaporating liquids.*

Claims applying heat by means of steam or heated air, separately or combined, to the upper and lower surface of oil or other liquid.

50,935—November 14, 1865; reissue 8,378—August 13, 1878. Division A. JAMES J. JOHNSTON. *Improvement in apparatus for evaporating liquids.*

Claims the combination of a vaporizing chamber, a steam and air superheater communicating therewith, and means for commingling the vapor, steam, and air in a highly heated condition.

52,284—January 30, 1866. H. P. GENGEMBRE. *Improvement in apparatus for extracting oil, etc., from minerals.*

This invention consists in an apparatus so constructed as to submit to the action of a solvent or solvents, in a rational, continuous, and progressive manner, the mineral containing oil, paraffine, or bitumen, and to recover the solvent or solvents by separating it or them from the oil, paraffine, or bitumen by a peculiar distillation.

52,509—February 13, 1866. CHARLES ADAMS. *Improved apparatus for bleaching oil, paraffine, wax, etc.*

This invention consists in an apparatus for bleaching oil, paraffine, or wax, so constructed as to submit these substances, while in the shape of vapors, to the action of steam under pressure, varying at pleasure, whereby all the impurities are removed from the oil, paraffine, or wax, and they are rendered perfectly white without the use of any chemicals.

55,855—June 26, 1866. C. H. HALL. *Improvement of distilling petroleum and other liquids.*

Claims the method herein described of separating the condensable from the noncondensable gases, or any other method whereby the condensable gases are made to collect in the lower part of a receiver while the noncondensable gases are made to pass off by the suction of a current of steam.

55,855—June 26, 1866; reissue 2,470—January 29, 1867. C. H. HALL. *Improved apparatus for distilling petroleum and other liquids.*

This improvement relates to an apparatus particularly designed for refining petroleum oil, but which may be used for refining coal oils, turpentine, or volatile liquids of any description. It consists, first, of a supply tank into which the crude oil or other liquid is first placed to be refined and in which it is partially heated; second, of a retort into which the oil or other liquid flows to be distilled and through which it passes in a thin stratum; third, of a chamber through which the vapors pass into the condenser; fourth, of a condenser in which the volatile portions of the oil or other liquids become condensed; fifth, of a receiver in which the products of condensation are collected and separated from the noncondensable gases; sixth, of a series of water and steam jackets inclosing the condenser in which steam is generated by the heat of the condensing vapors of the oil or other liquid being distilled; seventh, of a series of scrapers carried over the bottom of the retort to prevent the forming of a sediment on said bottom; eighth, of a purifying tank into which the residuum is forced by jet of steam; and, lastly, of a furnace and arch over which the retort is placed.

65,136—May 28, 1867. DEXTER SYMONDS. *Improvement in oil stills.*

Claims in stills for deodorizing and purifying oils where the substance or material used and the process of deodorizing and purifying are herein described, the employment of one or more screens.

68,974—September 17, 1867. SAMUEL GIBBONS. *Improvements in still for refining and distilling oils.*

This invention consists of a retort or still, made cylindrical or any other suitable shape, and placed in a horizontal position. Depending from and connecting with this still at its bottom are two chambers, to which are connected waste pipes. Running into this still from one end, and near its bottom, is a pipe, which is provided with a series of short pipes, which run crosswise of it and of the cylinder, said short pipes being provided with a number of small perforations. Also a pipe which passes down through the still and opens into one of the chambers for the purpose of conveying the oil into the still, and a pipe which communicates with the still at its top, for the purpose of conveying away the vaporized oil.

69,715—October 15, 1867. SAMUEL ANDREWS. *Improved safety valve for oil stills.*

The nature of this invention consists in the construction and application of a safety valve to be placed in the bottom of oil stills as a preventive against the flow of the contents of the still in case of accident of any kind happening to the tar pipe, as in the case of the breaking out of fire in oil refineries it has always been impossible to save the contents of the stills from being consumed, because of the breaking, bursting, or fracturing of the tar pipes from the falling of timbers or débris, or any of the causes incident thereto, and permitting the escape of the entire contents of the stills, thus greatly enhancing the dangers attendant upon the manufacture of oils, etc.; also, in extreme cold weather, pipes frequently burst from that cause and the contents wasted.

91,953—June 29, 1869. FRANCIS McCARTY. *Improvement in the distillation of hydrocarbon oils.*

Claims causing the oil in the still to move in a continuously returning current or flow, by means of a jet of steam, and a funnel inserted in the steam pipe back of the discharging aperture.

110,516—December 27, 1870. SAMUEL VAN SYCKEL. *Improvement in stills for petroleum and other oils.*

The still and furnace are constructed in the ordinary manner, and the dome, preferably of triangular form, is connected with the still. At or near the center of the still, and from the interior of the dome, suspend a series of pipes, connected with the steam boiler, somewhat resembling a gas chandelier. The ends or surfaces of these pipes are perforated, so that jets of steam may be thrown through them into the vapor above the surface of the oil. The dome is for the purpose of conducting the lighter vapors to the pipes connecting with the worm, as they, rising first, will fill the dome and keep the heavier ones from the conducting pipes until the steam jets act upon them.

122,810—January 16, 1872. CHARLES J. T. BURCEY. *Improvement in distilling and bleaching oils.*

Claims the combination of air tube heat chamber revolving hollow heater shaft heaters and hollow perforated arms in the retort.

133,425—November 26, 1872. HIRAM W. FAUCETT. *Improvement in apparatus for distilling hydrocarbons.*

Claims the combination of chemical box dripping pipes, and vapor pipes with condensing cylinder and perforated cylinder.

152,650—June 30, 1874. ROBERT KLOSTERMAN. *Improvement in apparatus for distilling oils, fats, and petroleum.*

Claims the combination of a still, a steam pipe, provided with a water trap, a blow-off cock, and an upwardly inclined nozzle.

156,265—October 27, 1874. J. PARK ALEXANDER AND WILLIAM EBERHARD. *Improvement in oil stills.*

Claims the combination of a still provided with the steam coil, which extends a short distance above the contained oil, provided with inlet pipe, which extends down into and to the bottom of the superheating chamber, a furnace situated a short distance below the still, and independent thereof; and a cylindrical superheater provided at its top with an inlet pipe and exit pipe, which extends down into and to the bottom thereof, said superheater placed entirely within the furnace at its top central portion, and extending from the top down into the furnace to near the bottom, whereby the heat in the furnace is made to pass all around and envelop the superheater on all sides.

168,542—October 5, 1875. CORNELIUS VAN DEVORT AND CORNELIUS VAN FLEET. *Improvement in distilling oils.*

Claims a convex metallic cove provided with a flange and stops in combination with a wooden tub, the flange forming a tight joint.

174,739—March 14, 1876. WILLIAM DOE. *Improvement in oil refineries.*

Claims the combination of still coil pipes, heater, and separator provided with a stirrer.

254,176—February 28, 1882. CHARLES J. TAGLIABUE. *Apparatus for distilling petroleum.*

Claims in an apparatus for distilling oils, the combination of a furnace, a liquid receptacle above the same, an oil tank and vapor chamber, a condenser, a vapor pipe leading from the vapor chamber to the condenser, a vapor pipe leading from the oil tank also to said condenser, an oil lifting pipe extending from the oil tank into the vapor chamber, and a steam pipe uniting at its end with the end of the oil lifting pipe and forming therewith a steam atomizer.

290,866—December 25, 1883. RICHARD DEAN. *Apparatus for distillation.*

Claims the combination with a still and a heater for heating the material before it is distilled, of a steam atomizer located within the still, said atomizer consisting of an oil chamber having an oil supply pipe communicating therewith and orifices opening into the still, a steam chamber provided with steam induction pipe and with small pipes or tubes extending into the oil chamber for atomizing the oil, and a steam coil located below the atomizer.

305,097—September 16, 1884. HENRY McMANUS. *Apparatus for treating refuse from oil refineries.*

The object of this invention is to utilize the waste product from coal oil and petroleum refineries known as "sludge," and which is ordinarily discharged into streams, watercourses, or the ocean. In producing a heavy hydrocarbon oil suitable for lubricating and other purposes, by subjecting the sludge to heat in an apparatus constructed to permit a free circulation, and thorough and uniform heating of the material, however thick and viscid it may be, and regardless of the extent to which it may foam, and claims—

The combination with a lower vessel having a heating apparatus connected thereto, of an upper vessel, a pipe leading from the upper part of the lower to the upper part of the upper vessel, a pipe leading from the lower part of the upper to the lower part of the lower vessel, and pipes leading from both vessels to the condensers.

411,894—September 17, 1889. WILLIAM H. PITT. *Apparatus for distilling crude petroleum.*

Claims the apparatus for distilling and deodorizing petroleum having sulphurous or other offensive odors, said apparatus consisting of a furnace with two fireplaces, a retort over one fireplace, and a deodorizing receptacle over the other fireplace, and a pipe opening into the upper part of the retort and passing down through the retort and out near the bottom of the latter to the said receptacle, which has a discharge outlet for the deodorized vapors.

415,876—November 26, 1889. FRANK W. MINSHALL. *Process of and apparatus for distilling and desulphurizing hydrocarbon oil.*

Claims the process of distilling and desulphurizing volatile hydrocarbon oils, which consists in heating a quantity of hydrocarbon oil of high specific gravity in a still, and injecting a lighter hydrocarbon oil into the still with steam and oxygen, the steam being alternately superheated or wet, according to the temperature of the bath.

431,386—July 1, 1890. THOMSON McGOWAN. *Apparatus for distilling oil.*

Claims the combination, with a still, of a chemical container located inside the still, said chemical container having a feed pipe extending outside the still and having an eduction pipe or opening discharging into the vapor space of the still.

444,803—January 20, 1891. BENJAMIN N. HAWES. *Apparatus for refining oil.*

Claims in an apparatus for refining oils, a steam generator and an oil vaporizing chamber, in combination with a desulphurizing chamber containing gravel or other like substance, an intermediate chamber partially filled with gravel and connected with the desulphurizing chamber and pipes connecting the steam generator and oil vaporizing chamber with said intermediate chamber.

469,777—March 1, 1892. HENRY A. DIEHL. *Production and manufacture of pure asphaltum, etc., from natural asphalt.*

Claims the process of obtaining pure asphaltum, which consists in subjecting the bituminous substance to a sufficient degree of heat in a closed primary retort to melt it, separating from the melted bitumen its earthy and solid impurities, and again submitting the thus purified bitumen to heat in a secondary closed retort to distill it.

477,153—June 14, 1892. CARL MARIA PIELSTICKER. *Distillation of hydrocarbon or other oils.*

Claims in an apparatus for the continuous distillation of oil, a supply tank, a coil, connections between the two, means for heating both tank and coil, means for forcing the liquid from the supply tank through the said coil, a steam jet or blast in connection with said coil, a retort through which the liquid is also forced, said retort being provided with baffle plates and a draw-off cock, a steam ejector fitted to said draw-off cock, a second heating coil in connection with the retort, an expansion chamber connected with one end thereof, a condenser in connection therewith, and a gas holder or other receptacle.

492,421—February 28, 1893. THOMSON McGOWAN. *Still for the distillation and purification of hydrocarbons.*

Claims in a still for the distillation and purification of hydrocarbons, the combination with a still body or shell, of shelf or diaphragm for supporting purifying material, circuitous passages formed for the distillates to pass through, said passages covered or constructed in such a manner that particles dropping from above them are prevented from dropping through them.

507,330—October 24, 1893. ROBERT H. LAIRD. *Process of and apparatus for deodorizing and refining crude oils.*

Claims the process of distilling oil, which consists in first introducing the crude oil to be treated into a vaporizer, then introducing steam at a temperature of substantially 212° to said vaporizer, whereby the alcoholic series of vapors are generated, then withdrawing said vapors, then introducing superheated steam to said vaporizer, whereby the oleic series of vapors are generated, and then withdrawing said vapors as in an apparatus for distilling oil, the combination with a boiler, a series of flues therein, a tubular oil chamber surrounding each of several of said flues, an inlet and an outlet for each of said oil chambers, a pipe affording communication between the steam space of the boiler and the inlet of said oil chambers, a receptacle outside the boiler, and a pipe communicating between said receptacle and said oil chambers.

531,660—December 25, 1894. STANLEY C. PEUCHEN. *Apparatus for vaporizing petroleum or other liquids.*

Claims in an apparatus for vaporizing liquids, a still to contain the liquid to be operated on, an electric heating apparatus for acting on said liquid, means for suspending said electric heating apparatus near the surface of the liquid, and wires connected with said heating apparatus and with the still at about the center of the latter, whereby said heating apparatus may rise and fall equally above and below the center of said still.

556,155—March 10, 1896. WALTER P. LOWE AND CHARLES W. BILFINGER. *Process of and apparatus for distillation of oil.*

Claims an oil still provided at its top portion with a heat-storing and heat-absorbing structure sustained therein, the lower portion of the still forming a receptacle for the collection of drippings from said structure, an oil admission pipe, a steam injector pipe therefor, both of said pipes being located in front of said structure, and a vapor exit pipe.

564,930—July 28, 1896. HERMAN FRASCH. *Apparatus for purifying petroleum.*

Claims in combination with an oil still and a condenser a purifying apparatus comprising a vessel containing a liquid bath, a number of columns of small diameter containing purifying material arranged in said vessel and surrounded by said bath, pipe connections between the vapor space of said still and the column inlets severally, so that every column receives its several portion of vapors given off together from the same body of oil in distillation, pipe connections between the column outlets and said condenser, and exhausters in communication with the said column outlets arranged to aid in counteracting differences in the resistance of the said columns.

629,586—July 25, 1899. ALEXANDER ADIASSEWICH. *Apparatus for distilling petroleum, etc.*

Claims an apparatus for distilling liquid, consisting of a heater, a cylinder heated by the latter, a chamber located at one end of the cylinder and into which the liquid is delivered, and a rotary, tubular shaft having helical scrapers and jet nozzles and extending through, communicating with, and receiving the liquid from said chamber, the liquid entering the shaft and issuing from the jet nozzles against the inside of the cylinder.

645,743—March 20, 1900. FRIEDRICH BERG. *Mineral-oil still.*

Claims a retort or still for vaporizing petroleum, comprising an oil receiving tank having a vapor outlet at the top, heating coils arranged at different elevations, respectively, within the tank, means for supplying and controlling the supply of steam to the said coils, and means for discharging and controlling the discharge of live steam into the tank at different elevations.

749,368—January 12, 1904. ADOLPHE C. G. DUPUIS AND WILLIAM S. FELL. *Distilling apparatus.*

Claims a distilling apparatus, comprising a liquid containing receptacle, the wall of said receptacle having corrugations formed therein, a conical vapor chamber mounted above said receptacle, a foraminous chemical-containing partition between the chamber and the receptacle, upwardly extending converging plates mounted in said chamber, a filling of nonconducting material for said plates, an outlet for the lighter vapors at the apex of said chamber, and outlet conduits for the heavier vapors, lying between the walls of the chamber and the aforesaid converging plates, said conduits converging and joining a common duct outside said chamber.

757,287—April 12, 1904. HORACE W. ASH. *Still for crude bituminous material.*

Claims the combination of a still for distilling crude bituminous material, a compartment at the exterior of the still, a furnace so located as to heat the exterior of the still, the interior of the furnace being in communication with the aforesaid compartment, the compartment being in communication with the interior of the still, whereby the products of combustion may pass from the furnace to the compartment and there heat the exterior of the still, and then pass on and be injected into the interior of the still.

786,828—April 11, 1905. EDWIN A. MOORE. *Tar dehydrater.*

Claims a tar dehydrater consisting of a receptacle provided with a supply pipe, an agitator having a tubular body and tubular arms, trunnions detachably connected to the body of the agitator and provided, respectively, with steam supply and discharge pipes, a detachable head at each end of the receptacle provided with tubular bearings and stuffing boxes for said trunnions, a tar discharge opening in one of the heads of the receptacle and in the plane of the level of the tar, and a condenser.

Subclass 4.—Stirrers and Scrapers.

22,973—February 15, 1859. JOHN NICHOLSON. *Improvement in retorts for distilling oils from coal.*

Claims the use of a curved blade or blades placed on the agitators or arms of a shaft, for the purpose of agitating, lifting, mixing, and bringing all parts of the mass within the retort in contact with the heat. Reissue 712, May 3, 1859. Covers the use of straight as well as curved blades.

23,719—April 19, 1859. WILLIAM SMITH. *Improvement in coal-oil retorts.*

Claims the making of hollow agitating arms, to communicate with a hollow shaft for the purpose of cooling them, by means of a current of air or water passing through the said shaft.

26,826—November 29, 1859. MATTHEW HODKINSON. *Improvement in retorts for distilling coal oil.*

Claims a stationary retort with a shaft armed with knives whose edges are at right angles with the shaft passing through it, by which, when motion is given to the shaft, the coal is broken and pulverized more effectually and more economically than by any other method.

51,042—November 21, 1865. CHARLES A. HARDY. *Improvement in oil stills.*

Claims constructing a still for the distillation of oil and other liquids with an outer chamber enveloping it on the top and at the sides so as to leave a space above and around or partly around the inner or main still, thus forming an outer and inner chamber, communicating with each other by means of one or more siphons or valves, for the purpose of heating the oil or other liquid and vaporizing its lighter constituents before its admission into the main or inner still, and thus effecting an economy of heat.

80,294—July 28, 1868. CHARLES LOCKHART AND JOHN GRACIE. *Improvement in stills for hydrocarbons.*

Claims providing a still for hydrocarbons with a valve, which will act from an internal or external pressure.

80,294—July 28, 1868; reissue 4,515—August 15, 1871. CHARLES LOCKHART AND JOHN GRACIE. *Improvement in stills for hydrocarbons.*

Claims in combination with an upright still a series of fire chambers radially arranged around and under the still, such chambers converging to a central smoke chamber connecting with a flue or chimney.

130,668—August 20, 1872. WILLIAM B. SNOW. *Improvement in apparatus for distilling petroleum.*

Claims the arrangement within a tank of a rock shaft carrying a dasher, a crank rod, and crank arm of a driving shaft for operation.

137,496—April 1, 1873. WILLIAM B. SNOW. *Improvement in oil stills.*

Claims a reciprocating dasher corresponding in contour, as described, with the transverse section of the tank, and arranged to move in a direction longitudinal with the latter, and at a slight but appreciable distance from the heating surface of the tank.

150,465—May 5, 1874. CORNELIUS J. CRONIN. *Improvement in stills for refining oils.*

Claims the improved still for refining petroleum, consisting of a still with end extension chambers, and reciprocating scraper plates for preventing the formation of the sediment on the bottom of the still and carrying the same into the end receptacles.

162,965—May 4, 1875. JOHN L. STEWART. *Improvement in petroleum stills.*

This invention relates to improvements in the construction of apparatus for the continuous distillation of oils of different density from a compartment still, or several stills connected together, and consists in dividing one still into two, three, or more compartments or sections, so that each compartment having separate fires can be heated to the necessary temperature to suit the density of the oil contained therein, and make oil of a different specific gravity from each compartment. These compartments are provided with scrapers secured to endless chains, which are mounted on shafts driven by power. These scrapers remove all sediment and paraffine oil from the bottom of each compartment into a receptacle at the back end, thereby obviating the necessity of having to stop to clean out the stills. Overflow pipes are so arranged in combination with self-acting valves controlled by floats as to carry off the heavy oil from the bottom of one still into the next contiguous still, and thereby maintain constantly the proper level of oil in each compartment. Also in the combination, with a compartment still for continuous distillation, of communicating pipes and automatic regulating valves, whereby the oil in each still is maintained at a proper level; also, in the combination, with a compartment still for continuous distillation, of a pipe or trough conveying the oil from rear pocket of one still to the front end of the next still; also, in making the said pipe as a conduit or lining along the side of the still, to form a lining of running oil between each compartment, and thereby prevent the temperature of one compartment being affected to any great extent by that of the next; also, in the combination, in a compartment still for continuous distillation, of scrapers arranged on endless chains; also, in the particular construction of the scrapers and the mode of connecting them to the chain; and, also, the general combination of parts which go to form the continuous scraping arrangement.

166,349—August 3, 1875. JULIUS C. DICKEY. *Improvement in oil stills.*

Claims a tank provided with an inclined partition in combination with a pump or other forcing apparatus.

209,943—November 12, 1878. OLE TILTON. *Improvement in oil stills.*

Claims in an oil still, a subchamber, provided with inlet openings and discharge tubes.

224,301—February 10, 1880. JAMES D. MEIGHER. *Still for refining petroleum.*

The object of this invention is to prevent all coking or burning of the oil while being vaporized, prevent chilling, preserve a uniform heat through the whole mass, cause more rapid vaporization, and preserve the color of the products, and, in making lubricating oils, to prevent them from chilling and becoming black and stringy, and this is accomplished by the agitation of the whole body of oil by mechanical contrivance while being vaporized by heat, and at the same time introducing a current of heated air into the oil to assist the vaporization and facilitate the flow of vapor through the pipes into the condenser.

252,981—January 31, 1882. GEORGE C. TREWBY AND HENRY W. FENNER. *Distillation of coal tar.*

Claims the apparatus for distilling coal tar, consisting of a main steam pipe with its controlling cock, small branch pipes, ring, losser branches, and outlets or jets in conjunction with a suitable form of still bottom.

405,738—June 25, 1889. ROSS J. HOFFMAN. *Evaporating apparatus.*

Claims in combination with the still for treating hydrocarbon oils, a steam pipe within said still arranged to substantially cover the surface exposed to the heat, the said pipe being placed close to said surface and being provided with discharge orifices opening directly against the said surface, whereby the jets of steam are caused to impinge directly on the surface to be protected.

490,144—January 17, 1893. HERMAN FRASCH. *Apparatus for refining petroleum.*

Claims the combination with an oil still having a furnace and a flue leading therefrom, of a purifier in the flue, and a feeder adapted to discharge the purifying material among the vapors in said purifier, which purifier communicates with the vapor space of said still and has a vapor exit pipe.

503,996—August 29, 1893. WILLIAM H. STELWAGON. *Tar or petroleum still.*

Claims a tar or petroleum still having a rotary agitator therein, the same being formed of rectangular and tapering vanes, whereby the material in the still may be raised and also directed laterally, and thereby caused to circulate.

553,191—January 14, 1896. HERMAN FRASCH. *Agitator for stills.*

Claims the combination with an oil still, of a number of narrow drags arranged side by side on the still bottom and provided with supporting and scraping edges which rest upon the still bottom in advance of one another and which keep said drags from turning over and conform to the still bottom even when it becomes warped, and means for drawing said drags flatwise over said still bottom while leaving them free to adjust themselves in all directions.

761,315—May 31, 1904. FRANCES B. MERRILL. *Still.*

Claims a horizontal still of uniform section from end to end, its bottom being curved in the arc of a circle described from a point near the top of the still, and the top being contracted, in combination with the pendent vibratory agitator, having a horizontal axis near the top of the still.

Subclass 5.—Condensers.

10,813—April 25, 1854. JAMES R. STAFFORD. *Improvement in distilling and condensing apparatus.*

Claims the employment, for the purpose of separating the more and less volatile products of distillation, of a vessel, which has an opening for the escape or withdrawal of condensed matters, and another opening for the escape of the more volatile matters, and which has its temperature regulated by the admission of steam or air through a pipe, passing through its interior or through a chamber, surrounding it.

24,561—June 28, 1859. WM. G. W. JAEGER. *Improvement in apparatus for condensing coal oil.*

Claims the employment of a fan blower when the same is used to draw the vapors from the retort.

24,561—June 28, 1859; reissue 1,902—March 14, 1865. WM. G. W. JAEGER. *Improvement in condensing and separating oils and gases.*

Claims in apparatus for condensing oils and other liquids, in combination, an annular condensing chamber, through which the vapors of oils and other liquids are to pass as they come from the retort or still, a condensing surface surrounding such chamber, and a condensing surface surrounded by such chamber.

24,920—August 2, 1859. WILLIAM T. BARNES. *Improvement in apparatus for condensing coal oil.*

Claims the employment of a tube, the lower extremity of which is provided with tubular arms, the same being made to revolve, and being used in connection with a tank partially filled with water, and a conducting pipe.

28,246—May 15, 1860. LUTHER ATWOOD. *Improvement in construction of apparatus for the redistillation of coal oils.*

Claims a separating chamber constructed when arranged and combined with a volatile oil still and condenser in such manner as to gradually separate and condense the heavier parts of the oleaginous vapors formed and continuously return them to the still for a further action of the heat, and at the same time preserve the lighter vapors and pass them over to the condenser.

28,341—May 22, 1860. JOHN F. BENNETT. *Improvement in apparatus for condensing coal oil.*

Claims subjecting the volatile products of the distillation of coal (composed of a mixture of various substances in the form of vapor) directly as it passes from the retort or prime generator to gradually diminishing degrees of heat in a succession of condensers, for the purpose of separating by one operation each of these several different substances from the other substances with which it is mixed when in the form of vapor, at the particular degree of temperature at which it assumes the liquid form as distinguished from the fluid or gaseous form, by means of an apparatus such as described when combined with a coal oil retort.

31,858—March 26, 1861. LUTHER ATWOOD. *Improvement in the manufacture of hydrocarbon oils.*

Claims the direct application of ice or ice and salt to the condensation of hydrocarbon oil vapors.

31,998—April 9, 1861. ABRAHAM QUINN. *Improvement in apparatus for distilling oils.*

Claims the rectifier composed of an inverted siphon with its faucets and other appendages, applied, in combination with still and condenser, in such manner as to be capable of effecting the several operations and purposes.

35,497—June 10, 1862. JAMES ADAIR. *Improvement in condensers for oil stills.*

Claims so constructing the worm chest of the condenser as to separate the different qualities of oil by partitions, which the condensed fluid can not pass, but which present no obstacle to the flow of the uncondensed vapor and gas through the worm.

36,403—September 9, 1862. CHARLES W. GRANNIS. *Improved condenser for coal oil stills.*

Claims a condenser which combines the following features, to wit: First, sloping sides; second, an internal trough to catch and conduct the condensed vapors to an external conductor; third, an external spout or conductor passing through or in a trough of cold water to conduct the condensed vapors to the worm or cooler; fourth, jets of water or a body of cold water upon its outside, in combination with a caldron or still having a broad open top, upon which the condenser is fitted, forming a cover thereto, so that the vapors arising from the entire surface of the oil in the still may pass directly to the condenser.

36,481—September 16, 1862. ABRAHAM QUINN. *Improvement in apparatus for distilling petroleum and other oils.*

Claims the arrangement of several rectifiers in combination with each other, with the still retort, and with the device or apparatus for feeding the crude oil in such manner that the vapors of the heavier oils on their way to the condensing apparatus meet the crude oil on its way toward the still retort and heat the latter oil to such an extent as to extract the vapor of the more volatile portions of it before it arrives at the retort of the still.

37,263—December 23, 1862. THOMAS K. PETTY AND WILLIAM G. WARDEN. *Improvement in oil stills.*

Claims the use in stills for distilling hydrocarbon oils, of a double trap, so connected with the still and its worm pipe or goose neck as not to return to the still the heavier vapors or any condensed products of distillation, but so that any unvaporized liquid or solid substances carried over with the vapor, or boiling over from the still, through the still head or goose neck, shall be arrested before reaching the worm or condenser, and either returned to the still or collected in a separate receptacle.

39,978—September 15, 1863. I. W. WETMORE. *Improved apparatus for condensing oil vapors.*

Claims the separate upward flowing currents above and below the vapor chamber, the propulsion of these currents on the principle of the siphon, the corrugation of the upper condensing surface, the breaks of wooden angles and doors in the vapor chamber, and a sprinkler.

47,293—April 11, 1865. CYRUS M. WARREN. *Improved apparatus for distilling petroleum, etc.*

Claims the special application of heat by means of a separate fire or its equivalent to a condenser attached to a still, for the purpose of controlling and regulating the temperatures of the vapors given off in distillation, in order to produce a more complete separation of the constituents of complex mixtures of liquids.

48,435—June 27, 1865. ELIJAH FREEMAN PRENTISS AND ROBERT ADAM ROBERTSON. *Improved apparatus for distilling petroleum.*

Claims the employment of bent vapor, steam, and air pipes, arranged, constructed, and operating substantially as shown and described.

49,020—July 25, 1865. L. N. WILCOX. *Improved apparatus for separating the products of distillation of hydrocarbons.*

Claims separating benzole from illuminating oils in distilling hydrocarbon oils and other substances by means of separate pipes arranged with traps, leading off from different parts of the condenser.

50,868—October 10, 1865. A. KREUSLER. *Improved apparatus for distilling petroleum.*

Claims the use of a series of adjoining condensing chambers, arranged substantially as described, for the purpose of separating the condensed liquids of different specific gravity.

52,277—January 30, 1866. SOLOMON B. ELLITHORP. *Improved refrigerator and condenser.*

Claims a refrigerator or condenser for cooling liquors or condensing vapors, consisting of an outer chamber, an inner chamber, and a system of perforated pipes.

53,528—March 27, 1866. J. H. FAIRCHILD. *Improved condenser.*

Claims a basin and perforated condensing pipe in combination with a water pipe and vapor pipe.

58,005—September 11, 1866. P. H. VANDER WEYDE. *Improvement in distilling petroleum and other liquids.*

Claims the production of a partial vacuum by suction produced in the still by a pump either between it and the condenser, or at the end of the tube intended for the escape of the noncondensable products, which vacuum may be filled by those noncondensable products—vapor, air, or steam—led to and admitted from the other end of the apparatus, provided with a safety valve.

60,166—December 4, 1866. ANDRE FOUBERT. *Improvement in distilling and refining oils, wines, and other liquids.*

Claims a column containing perforated diaphragms in combination with a worm or condenser and pipe passing back to the column.

61,120—January 8, 1867. ALEXIS THIRAULT. *Improvement in distilling petroleum.*

Claims the apparatus constructed to secure a continuous distillation by one single operation, being a combination of boilers and tar cock with hot-air chamber and all the pipes and other parts composing the said apparatus.

63,963—April 16, 1867. ALEXIS THIRAULT. *Improved apparatus for treating petroleum.*

Claims the arrangement of one or more steam jets in combination with a condensing coil.

65,884—June 18, 1867. SAMUEL DAVIS. *Improved mode of condensing noxious vapors from lard rendering, etc.*

Claims discharging a stream of water into the discharge pipe of a boiler, for the purpose of increasing the draught from the boiler.

66,243—July 2, 1867. CLARENCE MORFIT. *Improvement in condensers for stills.*

Claims a condenser, which is adapted for use in conjunction with a still, and which is divided into a number of chambers communicating with each other and provided with two series of pipes or conduits, so arranged as to admit of the separation and revaporization of the distillates and their return to the still.

68,257—August 27, 1867. CHARLES STOTT. *Improved apparatus for distilling and rectifying petroleum.*

Claims an apparatus for distilling and rectifying petroleum, in which steam is used in the still, or retort and rectifier.

86,232—January 26, 1869. C. M. JAMES. *Improved apparatus for distilling volatile hydrocarbons and other substances.*

Claims an arrangement of mechanism, by means of which the substance to be distilled, and the vapor to be condensed, either or both, are operated upon when extended in thin sheets or strata.

96,997—November 16, 1869. AUGUSTUS HENRY TAIT. *Improvement in stills for distilling naphtha and petroleum.*

This invention consists in a supplementary or ascending worm, and a condenser, placed over the still proper, up to or into which ascends all the vapors that are generated, and, where they become separated into light and heavy vapors, the heavy vapors falling back into the still, leaving the lighter vapors in the worm or supplementary condenser, whence they pass into a second condensing apparatus, where they are finally condensed, the naphtha or light oils formed from them being gathered into a suitable receiver.

117,426—July 25, 1871. JAMES J. JOHNSTON. *Improvement in processes and apparatus for treating hydrocarbon oils.*

Claims the combination of pipes constructed and arranged with relation to each other and a condenser, substantially as described.

117,873—August 8, 1871. HIRAM W. FAUCETT AND THOMSON McGOWAN. *Improvement in condensers for oil stills.*

Claims a longitudinal cylindrical perforated pipe, arranged within the condensing cylinder and communicating with the feed pipe in combination with vapor pipes surrounded by water in water box and operating in reference to the still.

118,602—August 29, 1871. ANDRE FOUBERT. *Improvement in apparatus for distilling and refining oils.*

This invention is especially for the refining of petroleum and separating the same into gasoline or naphtha, burning oil, and refuse coloring matter, and consists in the use of a column somewhat similar to that employed in a rectifying apparatus for alcohol, the parts being arranged so that the burning oils may be returned to the still or drawn off separately, and the gasoline or naphtha is condensed until the lighter oils are distilled entirely, after which the burning oil can be distilled. During the distillation the coloring matter and thick heavy oils are to be conveyed away to a separate receptacle, so that there may be no tar, heavy oil, or similar material to obstruct the apparatus when it is allowed to cool, or after each charge of the apparatus.

120,539—October 31, 1871. HENRY H. ROGERS. *Improvement in distilling naphtha and other hydrocarbon liquids.*

This invention consists in an apparatus for separating volatile hydrocarbons by repeated vaporization and condensation. The operation is continuous, and what is equivalent to a large number of fractional distillations is accomplished during a single distillation. The apparatus used is, in many respects, similar to what is known as the column still for distilling alcoholic spirits, but modified in all the details, so as to make it available for distilling oils. In the spirit still it is only required to separate two principal liquids—alcohol and water. But in the oil still a long series of liquids is to be separated.

123,907—February 20, 1872. SAMUEL HUDSON. *Improvement in distilling coal oils.*

Claims in distilling burning oil from petroleum, the use of a condenser of a temperature as high as the fire test of the oil, and passing away the uncondensed vapors freely and directly to the atmosphere.

132,263—October 15, 1872. CHARLES W. DURANT AND JOHN GRIFFITH. *Improvement in condensers for vacuum pans, etc.*

Claims the arrangement of a cooling jacket or apron between the vapor supply pipe of a condenser, and the injection pipe, said jacket or apron being made to dip beneath the bottom end of the injection pipe in the condenser.

133,426—November 26, 1872. HIRAM W. FAUCETT AND THOMSON McGOWAN. *Improvement in apparatus for refining hydrocarbon oils.*

Claims the arrangement of a supply pipe, injecting pipes, and vapor pipes, combined and operating in connection with a still and water box.

143,945—October 21, 1873. SAMUEL VAN SYCKEL. *Improvement in apparatus and processes for treating petroleum.*

Claims the process of treating crude petroleum with the resultant product of only oil and gas, by effecting the condensation of the oleaginous vapors, and the immediate return of the condensed product to the body of oil in the treating chamber, and carrying over only the uncondensable gases; and,

The combination of a vertical chamber, for treating crude oil, furnished at or near its lower end with a pipe or pipes for the admission of steam, and a condensing chamber arranged above, with condensing pipes for condensing the oily vapors, and a gas pipe from the dome or chamber above for carrying off the uncondensed gases.

'154,771—September 8, 1874. SAMUEL VAN SYCKEL. *Improvement in condensers for hydrocarbons.*

Claims in combination with a vertical condensing chamber, a vapor pipe admitting the vapors at or near its upper end, a water spray pipe discharging upward at or near its lower end, and a supplemental tubular condenser.

156,899—November 17, 1874. REUBEN D. TURNER. *Improvement in apparatus for refining oils.*

Claims the combination of oil evaporator, steam jacket perforated mixing chamber for the vapors of the oil and steam, drip pipe, and one or more condensers, all being arranged for operation.

168,060—September 21, 1875. ROBERT SPEIR AND JOHN MATHER. *Improvement in apparatus for condensing vapors, gases, etc.*

Claims the apparatus consisting of the shelves, blocks, provided with tapered openings, baffle plates, pipes and tanks, all combined and operating together.

170,730—December 7, 1875. MILO HARRIS. *Improvement in condensers for stills and drying chambers.*

Claims the combination, in an evaporating chamber, of a spiral or rabbeted condenser, having a longer vertical than horizontal dimension in its cross section, and having its inlet and outlet extended outside of the chamber, with a correspondingly spiral or rabbeted trough, to catch and convey the condensation.

213,395—March 18, 1879. JOHN DAUL. *Improvement in apparatus for rectifying petroleum.*

Claims in combination with a still rectifier and condenser, the separator with a pipe, for conducting the oil directly back to the still, and the attached pipe, for drawing off the water.

217,935—July 29, 1879. JOHN W. CULMER. *Improvement in apparatus for separating hydrocarbon oils.*

Claims in a separator condenser for hydrocarbons, a worm consisting of two or more straight pipes connected at recurring lower levels by couplings forming cross pipes in combination with a trap receiver, for each cross pipe and a separate tail pipe, having the upward bend between said trap receiver and the outflow end of said tail pipe.

224,037—February 3, 1880. JOHN H. NICOLAI AND WILLIAM F. NICOLAI. *Coal oil condensing and separating apparatus.*

This invention relates to means for separating the distillate from coal oil or petroleum stills into fluid bodies differing in specific gravity; and it consists in a worm tub or cooling vat and a closed separator provided with a pipe leading from the separator to the exterior of the vat, and having a worm section leading from the still to the separator, and also other worm sections leading from suitable parts of said separator to nozzles at the lower part of the vat, by means of which a heavy burning fluid and a light hydrocarbon are delivered from the respective nozzles at the same time.

226,151—April 6, 1880. WILLIAM ATWOOD. *Distillation of oils.*

Claims the combination, with a still for vaporizing hydrocarbon oil, of a condenser inclined upward from the dome or goose neck of the still, to cause the vapors condensing therein to flow back through the upward current of uncondensed hot vapors, a refrigerator or cooler connecting with the lower end of the inclined condenser by a pipe provided with a trap to prevent the passage of uncondensed vapor or gases through the refrigerator.

229,297—June 29, 1880. JAMES H. ALEXANDER. *Process of refining petroleum, etc.*

Claims the method of separating the products of distillation into several grades which consists in conducting the vapors from the still into a common receptacle wherein the vapors are allowed to separate, as such, by their own gravities, and then conducting them, according to their gravities, to separate condensing worms.

230,239—July 20, 1880. SAMUEL CHENEY. *Process and apparatus for distilling petroleum.*

Claims the process of producing lubricating oil from crude petroleum placed in a digester by driving off the gas with steam at a pressure of about 40 pounds and that portion of the petroleum adapted for illuminating oil by the action of live steam at a pressure of not over 75 pounds, allowing the heavy oil to cool, heating it and agitating it a second time by live steam at the pressure last mentioned, allowing it to cool, and heating it and agitating it by steam a third time, and then cooling the heavy or lubricating oil, with its condensed water, as slowly as practicable in receivers; and,

A separator made to receive condensed liquid from distillate of petroleum and water, constructed with inclined sides, partition inclined shelf, and waterway with its gate.

239,618—April 5, 1881. ALBERT NEILSON. *Process of and apparatus for distilling petroleum products.*

Claims the method of separating the products of petroleum by distillation, consisting in subjecting the vapors to the condensing action of one or more diaphragms of water attempered to condense the desired constituent of the oil and permit the passage of the next more volatile constituent to the condenser.

243,496—June 28, 1881. OTTO BRAUN. *Cooling apparatus for condensing vapors.*

Claims in a cooling apparatus a cooling pipe suspended from a plate and contracted at the upper end.

243,930—July 5, 1881. THOMAS MARRIN. *Apparatus for refining petroleum and tar.*

Claims the combination, in a refinery, of a tank, a series of siphon pipes having their lower end immersed in a cooling liquid in said tank, an elevated connecting pipe uniting the upper end or longest leg of the siphons, and pipe with the benzine tank, steam coil therein, and gas holder.

254,990—March 14, 1882. JOHN N. MARTIN. *Process of and apparatus for distilling oil.*

Claims the improvement in the process of distilling oil which consists in separating the primary distillate from the still into oil and vapor, partially or wholly condensing such vapor, then separating the resulting condensed products into oil and light vapor by subjecting them to the action of the primary hot vapor distillate, and finally conducting away and condensing separately the light and heavy products.

258,284—May 23, 1882. LOUIS DAUL. *Apparatus for rectifying petroleum.*

Claims in an apparatus for rectifying petroleum, in combination with the main portion or walls, perforated plates, pipes, and cup, the coils or worms situated just beneath plates and the hot water tank, and pipe connecting the worms with such tanks.

281,945—July 10, 1883. HERMAN FRASCH. *Process of and apparatus for the fractional distillation of hydrocarbon oils.*

Claims a process for the fractional distillation of hydrocarbon oils, consisting in introducing into the vapor from the still a vapor for which hydrocarbon oil has little or no affinity, and passing together such vapors through a series of condensers of different temperatures, and.

In an apparatus for the fractional distillation of hydrocarbon oils, the combination with a condenser provided with a vapor conduit, of pipes for supplying mixed vapor of hydrocarbon oils and steam or equivalent vapor to the lower portion of the condenser.

295,210—May 6, 1884. EDWARD KELLS. *Apparatus for distilling petroleum.*

Claims in combination, water box or tank, receiving box or boxes, immersed therein, condensing pipes opening into the receiving boxes, and discharge pipe provided with a bent tube, fixed to its underside.

309,927—December 9, 1884. CHARLES ANTHONY BURGHARDT. *Apparatus for condensing naphtha and other vapors.*

Claims a condenser or section of a condenser for use in the recovery of india rubber solvents and for other uses, divided into compartments by means of partitions of wire gauze or perforated plates extending through the shell or walls of the condenser into the body of cooling liquid outside the condenser.

310,497—January 6, 1885. RICHARD DEAN. *Process of and apparatus for the fractional distillation of petroleum.*

Claims in the fractional distillation of petroleum, the process consisting in passing the vapor from the still through condensing tubes or conduits (one or more), and conducting the uncondensed vapors backwardly in direct contact with said tubes or conduits, and thence into a condenser, whereby the uncondensed vapor serves as the sole condensing bath or medium for the vapor coming from the still, and drawing off the liquid condensed in said primary condensing tubes or conduits; and,

In an apparatus for the fractional distillation of petroleum, the combination, with a still and condensing tubes or conduits (one or more) communicating therewith, of a chamber inclosing said condensing tubes or conduits, and constructed and arranged to convey the uncondensed vapor issuing from the said tubes or conduits backwardly in direct contact therewith, and constitute the sole condensing medium therefor, a condenser connected with said inclosing chamber, and pipes for drawing off the liquid from the condensing tubes or conduits.

313,979—March 17, 1885. JOHN E. BICKNELL. *Apparatus for separating oil vapors.*

Claims the separation of the different grades of oil contained in one common invention which consists in a special construction having the object to insure the certain condensation of the vapors of the heavy oil, while the vapors of lighter specific gravity pass off separately, and also in means for accurately regulating the temperature of the condenser at all times.

389,988—September 25, 1888. CHARLES F. THUMM. *Refining petroleum.*

Claims the combination, with primary furnace and its retorts, of injector, and provision for admitting air, and a series of successive condensers and trap pipes leading from the same, and the retort wherein the oil is initially heated, the same being connected with the decomposing retort in the primary furnace by means of a trap pipe.

426,173—April 22, 1890. JAMES DEWAR AND BOVERTON REDWOOD. *Apparatus for the distillation of mineral oils and like products.*

Claims in an apparatus for distilling oil, the combination of the retort, the still head, in free communication with the retort, the condenser in free communication with the still head and provided with a regulated outlet, the oil pump having a pipe leading into the retort and extending nearly its full length, and the air compressing pump having a pipe communicating with the still head.

471,291—March 23, 1892. JOHN LAING. *Apparatus for destructive distillation of mineral oils.*

Claims the combination, with a still for the destructive distillation of mineral oils, of a loaded outlet valve and a relief tank interposed between the said outlet valve and an ordinary condenser, the said relief tank being used more or less as a condenser.

486,554—November 22, 1892. HENRY S. BLACKMORE. *Condenser.*

Claims in a condenser, the combination of an inverted conical outer vessel having an inlet pipe and a discharge pipe at its lower end portion and an inlet pipe at its upper end portion, the inverted conical inner vessel, having its exterior provided with a spiral flange, which gradually diminishes from the large to the small end of the inner vessel and has its outer edge in juxtaposition to the inner surface of the outer vessel, means for rotating the inner vessel, with its diminishing spiral flange, to force the condensed material toward the discharge pipe of the outer vessel, a movable cover and a water jacket surrounding the outer vessel and provided with a lower inlet pipe and an upper outlet pipe.

530,300—December 4, 1894. ALLEN H. DUNKLE. *Vapor condenser.*

Claims the condensing chamber provided with inlet and outlet openings, in combination with a central water pipe and a coiled water pipe, the ends of said water pipes projecting through the closed top of the condensing chamber and discharging thereon so as to overflow the exterior of the chamber.

596,874—January 4, 1898. HARRY W. HAND. *Condenser, distiller, and feed-water heater.*

Claims the combination in an apparatus for condensing, distilling, or heating feed-water, of a casing, a series of tubes, and tube-plates so arranged as to be detachable from the casing and forming a removable tube structure, with deflecting-plates carried by the removable tube structure.

619,512—February 14, 1899. ADAM SLUCKI. *Apparatus for heating or cooling gaseous media.*

Claims in an apparatus for heating or cooling fluids the combination of tubes forming a conducting way for one medium, a casing inclosing said tubes, and corrugated partitions separating the tubes, the crests of the corrugations extending between tubes nearly to the plane of the axis thereof, whereby thin spaces are formed around tubes and connecting slits, said slits and spaces forming a way or conduit for a second medium.

622,936—April 11, 1899. JAMES R. WHITING AND WILLIAM A. LAWRENCE. *Apparatus for separating and recovering valuable vapors.*

Claims an apparatus for recovering or restoring vapors to liquid form, comprising a main receiver, a refrigerator, a pipe leading from the main receiver into a coil in the refrigerator, a collecting vessel in said refrigerator, with the interior of which the coil communicates, a trapped pipe leading from the lower portion of said collecting vessel to another receiver, a vapor receiver having a valve controlled pipe connection with the upper end of the collecting vessel, a pump having a pipe connection with the vapor receiver, an air-tight tank for containing a liquid, a pipe leading from the pump to the bottom of said tank and having a perforated horizontally disposed portion, a coil in said tank communicating with and receiving the drip from the refrigerator, an air discharge pipe leading from the said tank, and a pipe leading from the upper portion of said tank to the said other receiver.

700,375—May 20, 1902. JOHN S. ROAKE. *Distilling apparatus.*

Claims in an apparatus of the character described, a condenser coil, a pipe leading from a retort, an elbow connecting said pipe and the coil, a boss on said elbow, a tapered casing detachably mounted on said boss, a jet nozzle extending into said casing and connected with a source of steam supply, a pipe connecting said casing with an elevated tank, and a pipe also connected to said casing and with an open funnel.

727,391—May 5, 1903. WILLIAM T. LEMAN. *Condenser.*

Claims a condenser comprising a casing having a plurality of flues extending therethrough, means for passing a cooling agent through said flues, means for admitting vapor into said casing at one side thereof, and an annular baffle plate arranged between the flues within said casing adapted to compel the vapors to pass around parallel to the outer wall thereof across the path of the outer flues, said baffle plate being apertured on the opposite side thereof to admit the vapors into the space within the same and into contact with the inner flues.

755,760—March 29, 1904. LOUIS GATHMANN. *Apparatus for distilling petroleum.*

Claims in a distilling apparatus, the combination of a liquid-heating means; a vaporizer in communication therewith; a condenser communicating therewith; means favoring the radiation of heat from the top walls only of said condenser; and means for drawing off fractions of the condensate along the course of said condenser.

Subclass 5.—Bottoms.

24,217—May 31, 1859. WILLIAM G. W. JAEGER. *Improvement in retorts for distilling oil from coal.*

Consists in providing certain side channels at the side of the retort and arching the bottom so that the heavier oils may be drawn off before they are charred.

32,567—June 18, 1861. J. G. COLLINS. *Improved method of securing bottoms to stills.*

Claims a ring or clamp in combination with the bottom and a flange, each formed and constructed as described.

32,704—July 2, 1861. JOSHUA MERRILL. *Improvement in the distillation of hydrocarbon oils.*

In the distillation of hydrocarbon illuminating oils from crude coal oil or petroleum it is customary to place caustic soda or caustic potash in the still for the purpose of removing undesirable matters from the oil. This practice, although apparently necessary to the production of good oil, is very destructive to still bottoms, which, being covered with the alkali, burn out rapidly. There is also a loss of fuel in heating the oil through the layer of alkali.

This invention consists in a mode of using caustic alkali within the still and in direct contact with the boiling oil without suffering it to lie on the still bottom by placing the alkali in a pan of suitable size and adapted for the purpose.

32,706—July 2, 1861. JOSHUA MERRILL. *Improvement in the construction of stills.*

Claims the still, as a whole, consisting of a cast iron top, wrought iron sides, and wrought iron seamless bottom, combined together by angle iron couplings, for the purpose of making a comparatively light and durable hydrocarbon-oil still.

33,955—December 17, 1861. JOSHUA MERRILL. *Improvement in constructing stills and still bottoms.*

This invention consists in a new kind of still bottom, viz, a formed seamless steel still bottom, and in combining it with the body of a still.

35,818—July 8, 1862. JACOB REESE. *Improvement in furnaces for coal oil stills.*

Claims the mode of constructing stills, the bottom of which is composed of more than one piece, and furnaces therefor in such manner that all the joints, seams, and rivets which are placed inside of the fire chamber shall rest upon or be covered by walls or supports of brickwork or cement, and thus protected from the direct action of the fire.

38,602—May 19, 1863. JACOB REESE. *Improvement in oil stills.*

Claims the use, in combination with the guttered fire walls inclosing the joints of the still, of air flues for the purpose of passing a current of cold air along and over so much of the joints and rivets of stills as are situate in that part of the still which is situate within the fire chamber of the furnace, and thereby preventing the opening of the joints and carrying off any oil which may leak from the still; and,

The use of two or more goose necks in a single still, where the still is so constructed as that a separate vapor space is formed for each goose neck, while the fluid distillate is allowed to pass freely between the compartments thus formed.

46,088—January 31, 1865. GEORGE H. S. DUFFUS. *Improvement in retorts for distilling petroleum.*

Claims in stills for rectifying petroleum and other oils, or producing illuminating or other oils or gases from any substances capable of treatment by heat, making the bottom of the retort with a dome, or its equivalent, rising therefrom up within its interior.

46,090—January 31, 1865. GEORGE H. S. DUFFUS. *Improvement in retorts for distilling petroleum.*

Claims in stills for rectifying petroleum, or in which oils, coal, or other substances are treated by heat, arranging the furnace or burner by which the heat is communicated or created so that it and the flames or incandescent fuel can be moved nearer to and farther away from the retort, according to the condition of the work.

61,291—January 15, 1867. WILLIAM C. WELLES. *Improved still for petroleum.*

The present invention consists, first, in securing the fire sheets or plates to the bottom of the still through the medium of a frame, whereby many important advantages are secured, and, second, in a novel arrangement of the furnace flues under the still, whereby the products of combustion after leaving the fire chamber are made to pass over the entire surface of the bottom of the still, thus effecting not only a great economy in coal, but diffusing a greater proportion of heat, and producing a much better quality of oil.

102,180—April 19, 1870. JOHN WARREN. *Improvement in stills for petroleum.*

The object of this invention is to furnish an adjustable standard or support for the still bottom, and also to provide for the opening or closing of the upper end of the tar pipe, at its point of connection with the still.

117,425—July 25, 1871. JAMES J. JOHNSTON. *Improvement in apparatus for distilling hydrocarbons.*

Claims a still with a corrugated heating surface, in which is a series of oil chambers elevated one above the other, and so arranged with relation to each other that the oil shall flow from the upper chamber in a broad thin sheet over a convexed surface into the chamber next below it, and thus flow down from one chamber to the other through the whole series.

136,567—March 4, 1873. JOHN L. STEWART AND JOHN B. DUBLER. *Improvement in oil stills.*

This invention consists chiefly in the mode of bracing the still, and supporting it over the fire; also in the device for returning the condensed oil back to the still; also, the construction and arrangement of the fire and brickwork.

142,615—September 9, 1873. HENRY RYDER. *Improvement in apparatus for distilling heavy oils.*

The main purpose of this improvement is to prevent, in a still, the collecting of carbonaceous or other heavy deposits on the surface directly over that exposed to the direct action of the flame of the fuel in the furnace.

It is frequently the case, with coal oil stills of ordinary construction, that the deposits on their bottoms are so great and become so hard and thick as not only to become a means of preventing the heat of the furnace from being absorbed by the contents of the still, but of so insulating the bottom of the still from the oily contents as to enable such bottom soon to be burned through or injured more or less by the fire.

191,406—May 29, 1877. JOHN T. COLEMAN. *Improvement in oil stills.*

Claims a cylindrical sheet metal still, divided longitudinally into sections, the said sections being connected together by continuous internal or inwardly turned flanges, the said flanges having pronounced rounded corners and connected by rivets.

213,157—March 11, 1879. CLARK ALVORD. *Improvement in oil stills.*

Claims the combination, with an oil still, of a series of metal rods fixed in the bottom of the same and extending up into the body of the oil.

492,419—February 28, 1893. THOMSON McGOWAN. *Still lining.*

Claims an inside lining or covering for stills consisting of an absorbent and practically noninflammable and indestructible material; and,

An inside lining or covering for stills consisting of mineral wool impregnated or saturated with plumbate of soda.

504,917—September 12, 1893. JOHN FREEL. *Retort for stills.*

In practice great trouble has been caused by reason of the incrustation of the bottom of the retort, owing to the accumulation thereon of the solid matters contained in the crude oil, and of the accumulation of solid deodorizing compounds which it is usual to place in the oil during the distilling process. This incrustation necessitates the frequent renewal of the bottom of the retort, thus entailing considerable expense.

The object of this invention is to overcome this objectionable incrustation, and it consists in providing the retort with a false bottom adapted to retain the solid matters, and constructed to permit a free circulation of the oil, so that the latter will act as a conductor of heat between the main and false bottoms, and will serve to prevent the flame from acting injuriously upon the retort.

The invention also consists in combining with the false bottom an agitating device arranged to stir or agitate the solid matters thereon.

Subclass 7.—Feeders.

38,699—November 10, 1863. H. P. GENGEMBRE. *Improvement in apparatus for distilling coal oils.*

This invention consists in certain means of feeding the still, by which the oil is delivered thereinto at a high temperature as fast as the distillation proceeds, so that the quantity in the still is always nearly the same, and by which the boiling over of the still is prevented.

41,858—March 8, 1864. ELIJAH FREEMAN PRENTISS AND ROBERT ADAM ROBERTSON. *Improved apparatus for distilling rock oil and other hydrocarbons.*

Claims the combination of a still with a series of columns, three or more; each column being set and maintained at the temperature necessary to separate the product condensable at such temperature, whereby at one continuous operation the crude oil is separated into the various products due to condensation at the different temperatures fixed upon.

41,858—March 8, 1864; reissue 2,316—July 17, 1866. Division 1. ELIJAH FREEMAN PRENTISS AND ROBERT ADAM ROBERTSON. *Improved process for distilling rock oil and other hydrocarbons.*

Claims feeding crude oil into the still through one or more condensers, so that the crude oil serves as a surface condensing bath to the oil vapor coming from the still, and at the same time the crude oil itself undergoes a separate partial distillation before reaching the main still.

41,858—March 8, 1864; reissue 2,317—July 17, 1866. Division 2. ELIJAH FREEMAN PRENTISS AND ROBERT ADAM ROBERTSON. *Improved apparatus for distilling rock oil and other hydrocarbons.*

Claims the combination of a still with a series of columns, two or more, each column being set and maintained at the temperature necessary to separate the product condensable at such temperature, whereby at one continuous operation the crude oil is separated into the various products due to condensation at the different temperatures fixed upon.

46,899—March 21, 1865. CHARLES A. HARDY. *Improved still for oils, etc.*

Claims the arrangement and combination of parts in a diaphragm still, consisting of float valves governing the inlets to the upper and lower compartments, respectively, and heads communicating with the separate escape pipes.

54,358—May 1, 1866. WILLIAM G. W. JAEGER. *Improved apparatus for continuous distillation.*

Claims in a distilling apparatus, drawing off from the bottom of the still continuously, or as often as required, the heavy oils and residuous matters of the charge, and at the same time feeding the still as the charge is reduced by a supply through a pipe which traverses or passes through that portion of the charge which is being withdrawn.

154,700—September 1, 1874. THOMSON McGOWAN AND SAMUEL VAN SYCKEL. *Improvement in feed pipes for oil stills.*

Claims a perforated coil pipe arranged within a still and connected with a feed pipe, whereby the hydrocarbons introduced are vaporized and allowed to escape through the perforations in the order of their respective gravities, as the hydrocarbon traverses the pipe.

544,516—August 13, 1895. ODILON PERRIER. *Method of and apparatus for continuous distillation of crude hydrocarbons, etc.*

Claims the method of distilling crude, liquid hydrocarbons in a continuous manner, for the purpose of facilitating the disengagement of the more volatile products at a comparatively low temperature, which consists in subjecting an inclosed current of the liquid, at one point in its flow, to agitation at a comparatively low temperature, in such a manner as to expose the liquid in thin films, then exposing the liquid, at a farther point in its flow to heat sufficient to vaporize it, and finally leading the hot vapors so generated back to the point where the agitation is proceeding.

Subclass 8.—Films.

44,187—September 6, 1864. WILLIAM ARCHER. *Improvement in distilling hydrocarbon oils.*

Claims continuously and fractionally distilling and separating the various parts of hydrocarbon oils by the application of superheated steam or heated air.

44,481—September 27, 1864. WILLIAM ARCHER. *Improvement in refining hydrocarbon oils.*

Claims the arrangement of machinery by which a thin sheet or film of hydrocarbon oil is by centrifugal action continuously made to flow over, and to become thoroughly permeated and cleansed by a volume of sulphuric acid or other purifying element.

53,964—April 17, 1866. L. V. FICHET. *Improved apparatus for distilling petroleum.*

This invention relates to an apparatus composed of a hollow drum and steam coil, which are heated by superheated steam and surrounded or covered by a suitable jacket, in combination with a helical trough commencing on the top of the steam drum and extending down to its bottom in such a manner that crude petroleum or other liquids let into the top end of the helical trough are gradually heated and partially evaporated, and those parts of said liquids which reach the bottom end of the troughs in a liquid state drip down upon the highly heated steam coil, where they constantly flash into vapors, and the distillation of petroleum or other liquids can thus be conducted without interruption and without danger of an explosion or conflagration.

55,071—May 29, 1866. SILAS R. DIVINE AND CHARLES A. SEELY. *Improvement in apparatus for distilling.*

This invention consists in providing the interior of the body or shell of a still with a pipe leading gradually to the bottom of the still, said pipe acting as the heating surface, and being wholly or partly surrounded with a channel along which the liquid to be vaporized shall flow.

58,818—October 16, 1866. C. H. HALL AND JOHN ELLIS. *Improved distilling apparatus.*

Claims passing the vapors through a closed vessel containing a pipe or pipes through which cold water passes, said vessel being provided with one or more discharge pipes to draw out the condensed liquid of any desired gravity.

63,789—April 16, 1867. JOHN ELLIS AND EDWARD C. KATTEL. *Improved apparatus for distilling and refining petroleum, etc.*

Claims the using of steam and superheated steam for the purpose of separating and removing the more volatile from the less volatile portions of petroleum, kerosene, benzine, naphtha, and turpentine while these fluids are in a state of spray or drops.

67,988—August 20, 1867. E. G. KELLEY. *Improved petroleum still.*

Claims providing a still for petroleum or other hydrocarbon liquids with two pipes for carrying off and separating the products of distillation.

72,125—December 10, 1867. HERBERT W. C. TWEDDLE. *Improvement in apparatus for distilling oils.*

Claims a trough or troughs having perforations for the passage of the oil in small quantities, and furnished with points near to such perforations, so as to cause the oil to pass therefrom in drops or fine streams, or thin films or layers, over heated pipes or tubes placed thereunder, when used within a vacuum still.

72,126—December 10, 1867. HERBERT W. C. TWEDDLE. *Improvement in distilling hydrocarbon oils.*

Claims securing a continuous and complete distillation of hydrocarbon oils, by causing the oil to flow over the surfaces of a succession of heated pipes in different vacuum stills, the temperature of such pipes increasing in each successive still, so as to drive off at first more volatile ingredients and then those less so, and so on till only the residuum remains.

84,195—November 17, 1868. EDWARD G. KELLEY. *Improved petroleum still.*

This invention consists in the application of an adjustable gate between two vessels for the purpose of regulating the gravity of the products of distillation, and the application of a self-recording gauge, which will indicate the height of the liquid in the main still.

85,810—January 12, 1869. S. GIBBONS. *Still for refining and distilling oil.*

Claims applying the steam, for vaporizing, over or above the body of the oil so as to heat it without agitation and prevent carrying over the unvaporized particles of oil.

91,477—June 15, 1869. JAMES J. JOHNSTON. *Improved apparatus for distilling hydrocarbons.*

Claims separating the lighter part of hydrocarbon oil from the heavy part, by causing it to flow through a series of layers of charcoal placed on a series of inclined ways, arranged in a chamber, provided with suitable means for drawing off the heavy part of the hydrocarbon oil.

93,952—August 24, 1869. H. J. BERG. *Improved apparatus for removing benzine from hydrocarbons.*

Claims the method for removing the benzine and other volatile matters from crude petroleum, by causing the crude oil to flow gradually in a thin stream over a heated plate, whereby the volatile principles will all be evaporated with great certainty and rapidity.

105,585—May 24, 1870. HENRY A. STEARNS. *Improvement in apparatus for distilling hydrocarbons.*

Claims the improved distillery apparatus consisting of a chamber with suitable inlets and outlets, and provided with a series of alternating hollow flat surfaced evaporators, the interiors of which are connected and so arranged that a current of steam may be forced from one to the other throughout the series.

190,483—May 8, 1877. HERMAN FRASCH. *Improvement in apparatus and processes for the separation and treatment of oils.*

Claims the process for the separation and treatment of oils, consisting of causing them to pass in thin films over heated pipes or other surfaces in contact with an air draft in an air flue, and passing the said draft and separated light oils afterwards through suitable condensers and receivers.

205,792—July 9, 1878. HERMAN FRASCH. *Improvement in apparatus for distillation of oils.*

Claims in an apparatus for separating from oil its more volatile ingredients and for collecting the different products, a vaporizer, feeding mechanism for delivering the liquid to be treated in drops, films, spray, or other disseminated form upon the vaporizer, said vaporizer being disconnected from any condensing surface that would direct any product of condensation back into the liquid that has passed over the vaporizer, and in connection therewith a condenser substantially parallel with and in such close proximity to the vaporizer that the vapors set free will be condensed as soon as they are given off, said condenser and vaporizer provided with separate conduits to gather the respective products.

498,518—May 30, 1893. ROBERT H. LAIRD. *Apparatus for vaporizing oil.*

Claims in an apparatus for vaporizing oil the combination of an outer shell, a series of metallic distributing plates within said outer shell, each of said distributing plates having its upper surface downwardly inclined from the middle to a point near the periphery and upwardly inclined from said point to its periphery, means for supplying oil to said apparatus, means for supplying heat to the said distributing plates and means for conducting away the vapors as they are generated.

Subclass 9.—Furnaces and Flues.

25,552—September 20, 1859. MORRIS L. KEEN. *Improved mode of distilling liquids from coal tar.*

Claims the application of additional heat at or near the surface of the coal tar or other similar hydrocarbon, when used in combination with pressure in the boiler, for the purpose of preventing the tarry foam from rising and overrunning the still, and thus endangering the operator as well as the premises.

33,905—December 10, 1861. G. T. SAWYER, W. HOWLAND, JR., AND T. C. HATCH. *Improvement in setting stills.*

The object of this invention is to obtain a uniform heat under all parts of the bottom of a still, retort, or kettle; and the invention consists in the arrangement near the outer edge of the bottom of the still, retort, or kettle of a series of diving flues communicating with a flue which runs all round the setting at, below, or near the level of the lower part of the fire chamber and connects with the main flue or chimney.

34,816—April 1, 1862. S. G. CLARK. *Improvement in stills for coal oils.*

Claims the combination of a steam retort with a fire heat retort, arranged and operating as and for the purpose specified.

45,863—December 6, 1864. HERBERT W. C. TWEDDLE. *Improved mode of utilizing the waste gas from petroleum distilleries.*

Claims the mode of heating the furnace of stills for distilling petroleum or carbon oil by means of the permanent gas evolved from the petroleum in the stills during the process of distillation.

48,265—June 20, 1865. A. DUBREUIL. *Improved apparatus for distilling petroleum.*

Claims the use of boiling water inside the retort or still to vaporize the material known as "petroleum" or "rock oil."

48,896—July 25, 1865. JOHN BIBBY AND ALLEN LAPHAM. *Improvement in stills for distilling petroleum.*

Claims an elevated exit chamber in combination with a chimney or flue which passes through the center of the still.

49,740—September 5, 1865. LEVI S. FALES. *Improved method of setting stills.*

Claims the combination under one retort of two furnaces, two parallel partition walls which partly support the bottom of the retort, and a central or intermediate return flue, common to both furnaces and forming their communication with the chimney, the whole constructed and arranged within the inclosing walls of the still.

57,311—August 21, 1866. JAS. B. GRANT. *Improved apparatus for distilling oil.*

Claims the employment, in apparatus or machinery for distilling and refining petroleum and other oils, of a series of heating pipes set in the form of two cones, the bases of which meet and through which the products of combustion from the furnace pass.

58,197—September 25, 1866. SAMUEL ANDREWS. *Improvement in distilling oil.*

Claims a fire chamber and a reverberatory chamber, in combination with throat C' and an opening 1, in the manner and for the purpose substantially as set forth.

59,317—October 30, 1866. ALLEN LAPHAM. *Improvement in stills for petroleum.*

The nature of said invention consists in an arrangement of flues, dampers, and tubes whereby heat is applied only to those portions of the still that are below the level of the petroleum therein, so that neither the still nor the products of distillation are injuriously affected, and the heat from the fire is turned off from the upper flues as the level of the liquid descends.

61,098—January 8, 1867. LYMAN PRAY. *Improved distilling apparatus.*

Claims the arrangement of one or more shelves in the fire chamber of a still to operate in combination with the still, flues, and dampers.

62,750—March 12, 1867. JOHN HUNTINGTON. *Improvement in the construction of stills for oil.*

Claims two flues and a damper or their equivalents arranged in relation to an annular flue surrounding the base of the still, and operating conjointly in such a manner as to be combined with a single or double furnace to diffuse a uniform heat without injury to the oil or burning of the still, and also to induce a current of cold air to reduce the heated oil and still.

99,081—January 25, 1870. JOHN GRACIE. *Improvement in stills for hydrocarbons and other substances.*

Claims a main still or evaporator, in combination with one or more separate communicating heaters, the latter being arranged so as to be acted on externally by the heat, and the former being protected therefrom.

112,751—March 14, 1871. WILLIAM GRAY WARDEN. *Improvement in apparatus for distilling petroleum and other liquids.*

Claims a still or boiler, consisting of a vessel, having an internal flue closed at the top, so as to have a downward draught, in combination with a continuous annular flue surrounding the vessel and communicating with the fireplace, and through tubes with the said internal flue.

114,803—May 16, 1871. JOHN GRACIE. *Improvement in stills for oil.*

Claims in counter distinction to a vertical still for hydrocarbon oil, a horizontal still, the bottom of which is free from the direct application of distilling or decomposing heat, combined with a flue or flues, and condensing apparatus.

117,405—July 25, 1871. JOHN GRACIE. *Improvements in stills for oil.*

Claims a still provided with a series of horizontal return flues, communicating with fire chambers and a smoke flue or flues.

117,406—July 25, 1871. JOHN GRACIE. *Improvement in stills for oil.*

Claims a still, constructed with a series of flues arranged horizontally, or nearly so, a little above the bottom, and converging to a common center, so that its bottom shall be free from the direct application of a distilling or decomposing heat.

126,508—May 7, 1872. SAMUEL VAN SYCKEL. *Improvement in relieving oil stills of gas, etc.*

Claims relieving an oil still of its gas and inflammable products by means of a current or currents of steam acting upon the gas for the twofold purpose of drawing the gas from the reservoir and forcing it into the furnace with the steam, to be burned and utilized.

152,440—June 23, 1874. SAMUEL VAN SYCKEL. *Improvement in the distillation of hydrocarbon oils.*

Claims a still, provided with a series of pipes, extending downward from the bottom plate into the fire box, and opening into a common refuse pipe at a point below the fire level.

158,042—December 22, 1874. CHRISTOPHER CUNNINGHAM. *Improvement in the manufacture of oil stills.*

Claims the combination, with a still chamber, of a vertical pipe passing through the oil chamber, and connected at its lower end with the bottom, and provided at its upper end with a horizontal or cross flue, open at both ends and communicating with the surrounding flue for bracing the bottom of the still, and providing an enlarged heating surface.

191,203—May 22, 1877. SAMUEL VAN SYCKEL. *Improvement in continuous distillation and apparatus therefor.*

Claims the process herein described for distilling hydrocarbon oils, which consists in heating the contents of the still uniformly throughout, and delivering the oil to be distilled into the chamber near the surface of the contained oil, after the incoming oil has acquired the temperature of the body of oil in the still, whereby the body of the oil in the still remains undisturbed, and the distillation may be conducted at low temperatures, and in a system of stills arranged for continuous distillation, the combination of two or more stills having heating flues which surround and traverse the stills, the stills being connected by oil-supply pipes which pass through their lower parts and deliver the vapor into the vapor spaces and the oil below the surface of the oil of the respective stills.

191,204—May 22, 1877. SAMUEL VAN SYCKEL. *Improvement in oil stills.*

Claims in combination with an oil or similar still, having surrounding and traversing flues which extend to the height of the oil within the still, a supply pipe which rises within the still from a point at or near the bottom of the still and delivers just below the liquid level, and having branch pipes for the escape of the vapor.

205,407—June 25, 1878. GEORGE MILES. *Improvement in oil stills.*

Claims a horizontal still, combined with fireplaces and flues, and having its bottom semielliptical in transverse section, its ends concavo-convex, and its crown curved transversely and sloped from its ends upward to its middle.

212,084—February 4, 1879. CHARLES M. GEARING. *Improvement in stills for hydrocarbon oils.*

Claims the combination of an upright still with inlet and outlet pipes, an exterior casing a furnace with a V-shaped deflector, and a dome with damper.

214,199—April 8, 1879. WATSON RYDER. *Improvement in apparatus for the continuous distillation of hydrocarbon oils.*

This invention consists in a furnace having a curved arch-shaped roof, so located as to project up above the level of the bottom of the sides of the still, in combination with a grate placed at or near the level of the bottom of the sides, whereby the desired pockets are formed for the collection of the deposits without accumulating at points immediately over the fire, the form of the roof of the furnace being such as to afford the greatest strength for resisting the pressure from above and best adapted to allow the heat to be absorbed by the contents of the still, which, in connection with the location of the grate and of cold-air flues of peculiar construction, prevent the top and curved sides of the fire chamber from being burned, warped, or otherwise injured, the low position of the grate admitting of a large area for the fire chamber, and being at a convenient height to supply fuel thereto—a feature of importance in this class of stills, where they are necessarily elevated, in order to locate the tar condenser or drawing off apparatus below the still.

214,946—April 29, 1879. HENRY E. PARSON. *Improvement in apparatus for utilizing waste gases of distillation in refining petroleum.*

Claims the combination of an oil pipe connecting the condensing coil and receiving tank, and of an injector of a petroleum still, the oil pipe having one or two gas chambers or receivers, with a gas returning pipe and with a gas escape pipe, storing and distributing tube, and exit pipe opening into the atmosphere.

219,548—September 9, 1879. ELIJAH WESTON. *Improvement in oil stills.*

Claims a still for volatilizing oils by heat, provided with internal partition plates adjacent to the heating surfaces, and forming open passages for a free circulation, whereby the oil is brought in direct contact with the heating surfaces in separated quantities.

240,914—May 3, 1881. HIRAM E. LUTZ. *Petroleum still.*

Claims in an oil still for continuous distillation of petroleum one or more pockets or auxiliary receptacles to collect the separated tar from every part of the still and feed it to one or more points forming part of said pockets, said receptacles or pockets being wide and circular or curved at the top, where they open into the annular space of the still. and being pointed, or nearly pointed, at the bottom.

251,770—January 3, 1882. JOHN B. DUBLER. *Oil still and attachment.*

This invention consists of a still, of any suitable shape or size, provided with an adjustable fire check, so that the heat from the fires will always be upon the bottom of the still and at the same time be on a line with the top of the oil in the still.

269,382—December 19, 1882. ASA A. BUSH. *Still for refining petroleum.*

Claims a still for refining petroleum, consisting of the body, provided with an annular depressed ring, said depression being provided with two or more sets of direct and return flues.

298,826—May 20, 1884. ROLLIN C. CLARK AND MURRAY H. WARREN. *Petroleum still.*

Claims in a petroleum still, the combination, with a heating chamber, the lower portion of which is divided into two parts by a bridge wall, a flue communicating with one portion of said chamber, and a flue or opening in the bottom of the other portion of said chamber, of a vertical still supported on standards directly over the last mentioned opening and provided with vertical flues.

739,757—September 22, 1903. WATSON RYDER AND JOHN A. QUALEY *Still for petroleum oil or hydrocarbon fluids.*

Claims in a petroleum still, a furnace and a retort, the latter having a flue therein for the products of combustion, the same being connected with the crown sheet of the retort, which crown sheet is adapted to yield with the expansion of said flue without becoming disconnected therefrom or fracturing said flue, and air ducts at the base of said retort connecting with spaces at the rear of the retort between its rear crown sheet and the adjacent end of the furnace.

Subclass 10.—Heads.

12,852—May 15, 1855. FRANCIS BOWMAN. *Improvement in rosin stills.*

Claims the arrangement of a still by inserting a metallic tube and section of a tube, covered with glass inside and outside, or a similar tube, not covered with glass, projecting at any distance from the inside toward the center of the upper section of the still; also the suspension of the inverted bowl covered with glass inside and outside.

20,562—June 15, 1858. JOHN HOWARTH. *Improvement in apparatus for distilling oils.*

Claims in combination with a still, a reservoir, placed above the level at which the oil is to be kept in the still, and a worm, heated as described or in any other manner, whereby heated oil under pressure is fed into the still in such a manner as to keep the oil therein always at one and the same level.

52,151—January 23, 1866. LEVI S. FALES. *Improved apparatus for the distillation of tar and other substances.*

Claims in connection with a cooling chamber at or near the outlet of a retort, between it and the ordinary condenser. for the separation of the heavier from the lighter vapors eliminated in the distillation of tar and heavy oils and substances, the employment of means of regulating the supply or action of the cooling medium, whereby a uniform density of light oil is obtained.

59,334—October 30, 1866. JOHN F. COLLINS. *Improved apparatus for distilling petroleum, etc.*

Claims so constructing the mouth of a still, and combining it with a goose neck or exit pipe, as to provide for the admission of air around the mouth specified.

235,281—February 2, 1880. HENRY GOLDWATER. *Apparatus for vaporizing liquids.*

Claims in combination with a still, casings and means for arresting the current of vapor and projecting it with its contents downward, pipes leading from the casing above the retort, and communicating with the upper portion of the chamber.

340,499—April 20, 1886. HERMAN FRASCH. *Process of and apparatus for distilling hydrocarbon oil.*

Claims an oil still having in immediate proximity to the still and in free communication therewith a dome of the proportions and filled with irregular blocks or pieces of about the size stated, and having also the vapor escape pipe leading from said dome, so that the hydrocarbon vapors in leaving the still pass by tortuous paths without appreciable resistance through material of practically the temperature of the boiling oil. and deposit thereon any particles of liquid held in suspension without being themselves condensed to a material extent.

353,362—November 30, 1886. GEORGE H. KLINE. *Process of distilling petroleum.*

Claims in the process of distilling crude petroleum, passing the light vapors of the petroleum through a thin layer of divided material located upon a perforated diaphragm above the surface of the liquid and within the body of the still, and which material is at a lower degree of temperature than the vapors and does not substantially act chemically upon the vapors, whereby the heavier vapors are obstructed and caused to return for redistillation.

366,487—July 12, 1887. J. MORITZ KRIESER. *Process of and apparatus for distilling petroleum.*

Claims in the process of distilling petroleum, the improvement consisting in passing a current of a cooling medium through the still near the bottom thereof without coming into immediate contact with the oil, whereby the tarry matters and heavy oils are kept at the bottom of the still.

366,720—July 19, 1887. HENRY GOLDWATER. *Apparatus for refining illuminating and lubricating oils.*

Claims in a distilling apparatus, the combination of a main retort with subretorts, a suitable furnace for heating the same, a chamber seated thereon, a pipe connecting the bottom of the chamber with the subretort, and pipes for leading off the vapors from the retort and subretort.

384,708—June 19, 1888. J. MORITZ KRIESER. *Apparatus for vaporizing liquids.*

Claims in a petroleum-distilling apparatus, the combination of the still, the dome or discharge pipe, the shallow chamber above the still, the vapor chamber above the shallow chamber, the pipes leading from the shallow chamber to the top of the vapor chamber, means, such as an arresting cap and return pipes for arresting and returning the principal portion of the heavy vapors and unevaporated liquid, the series of vessels having concave tops and level rims, forming basins or traps, arranged one above the other, so that water overflowing the top basin will trickle down the sides of the vessel and the intervening pipe to the next beneath, a pipe for flowing cold water on to the upper trap, and a pipe for carrying it away from the lower one.

432,525—July 22, 1890. HENRY GOLDWATER. *Apparatus for purifying vapors.*

Claims in an apparatus for purifying vapors, a retort and suitable passages, in combination with a casing and a series of removable pans arranged so that a portion of an annular passage is provided between such series and the casing, and with a perforated floor and movable perforated plate.

443,328—December 23, 1890. THOMSON McGOWAN. *Apparatus for distilling hydrocarbons.*

Claims in a distilling apparatus, the combination, with a still and a trough on the inside wall or walls of the still, of a diaphragm located between the trough and the dome of the still, pipes in said diaphragm for the upward passage of vapor, and a discharge opening or pipe leading from the trough outside of the still for conducting off the products of distillation.

454,061—June 16, 1891. THOMSON McGOWAN. *Apparatus for distilling.*

Claims the combination, with a still and a diaphragm for dividing the still into two compartments, of a cylinder or container located over an opening in the diaphragm and supported by the latter, said cylinder or container having one or more screens supported thereby, and having a perforated hood with bent tubes.

553,206—January 14, 1896. DAVID CANTOR. *Distilling apparatus.*

Claims in a distilling apparatus, the combination of a boiler with an upright pipe leading therefrom, a pan supported thereon, a cover therefor carrying a condensing sheet and having an upright pipe, a plurality of similar pans and covers connected in like manner, and a system of drain pipes leading from the bottom of each pan to the still.

Subclass 11.—Apparatus—Stills and Jackets.

3,067—May 2, 1843. JOHN THURSBY. *Improvement in tarring yarn.*

Claims the compound or admixture of tallow or other oleaginous substances with turpentine, oil of tar, gum elastic, spirits of turpentine, and tar.

7,124—February 26, 1850. ANTHONY M. POISAT AND DAVID C. KNAB. *Improvement in distilling oleaginous matter.*

Claims facilitating and improving the distillation of fatty and oleaginous substances by the introduction of steam at or near the bottom of the boiler containing such substance, in combination with the application of external heat.

11,059—June 13, 1854. SAMUEL CHILDS. *Improvement in stills for distilling fatty bodies.*

Claims the use of a stratum of steam within a jacket or case between a fire heat and a vessel containing any article under treatment, whereby the heat applied to said vessel can be any desired amount, and the same can be regulated to any desired point, according to the supply and delivery of the steam.

20,455—June 1, 1858. LEONARD BELLINGRATH, JR. *Apparatus for distilling turpentine.*

Claims the arrangement of the inclosed air space between the alembic and outer jacket or case, when said air space is furnished with air passages, and an indicator of heat, so that the inclosed air may be heated by conduction instead of by the direct application of the fire.

32,951—July 30, 1861. JOSHUA MERRILL. *Improvement in casings of stills.*

Claims inclosing a still so as to surround the sides of the still with a confined air space or chamber.

40,168—October 6, 1863. CHARLES A. HARDY. *Improvement in oil stills.*

Claims the use of a cylindrical still (for distilling coal oil without the direct application of a furnace), such still having an inner or false bottom, forming a hot-air or steam space on the under side of the still.

41,871—March 8, 1864. ALEXIS THIRAULT. *Improvement in distilling rock oil.*

Claims subjecting petroleum or rock oil to repeated evaporations by condensing the vaporous products in one and returning the condensed liquid to the still through another pipe.

46,039—January 31, 1865. GEO. H. S. DUFFUS. *Improvement in retorts for distilling petroleum.*

Claims in stills for rectifying petroleum and other oils or producing illuminating or other oils or gases from any substances capable of treatment by heat, covering the still with a jacket inclosing or composed of nonconducting materials.

46,923—March 21, 1865. ADOLPH MILLOCHAU. *Improved apparatus for distilling petroleum, etc.*

Claims the distillation of heavy and light oils jointly to produce a burning oil by means of a second still within the main still for petroleum and similar oils.

53,167—March 13, 1866. ADOLPH MILLOCHAU. *Improvement in distillation of petroleum.*

Claims the method of preparing crude oil for distillation by evaporating the benzine and other volatile substances by a coil of pipe containing heated vapors and returning the condensed benzine into the crude oil.

62,362—February 26, 1867. ALONZO C. RAND. *Improvement in stills.*

Claims surrounding and enveloping a still with an adjustable covering or jacket, filled with a nonconducting substance.

66,841—July 16, 1867. C. G. HOWELL. *Improved apparatus for distilling and refining petroleum.*

Claims distilling, refining, and reducing petroleum and other liquids by the direct action of heat to the heating vessel and by the action of steam on a retort placed in a steam boiler.

77,094—April 21, 1868. CHARLES W. REQUA. *Improvement in stills for distilling hydrocarbons.*

Claims the use of steam in the distillation of liquid hydrocarbons in stills heated by external fire, when the steam is introduced into the still in such a manner that the lowest stratum of liquid therein will be continually removed from contact with the bottom of the still by the action of the steam, and its place supplied with fresh liquid from above.

97,998—December 14, 1869. JOHN WARREN. *Improvement in stills for oil, etc.*

This consists in the employment of a perforated convex arch over all of the fires, for the purpose of distributing the heated gases more evenly beneath the still bottom; in withdrawing the heated products of combustion from the circumference of the combustion chamber; in running all of the smoke flues from the chamber of combustion into one common chamber within the foundation of the still, at its center, radially, and from thence through the main flue into the chimney; in the employment of a hollow central pier, so arranged that the upper portion thereof shall contain the tar pipe, and the lower portion of said pier shall serve for the central receiving chamber of the smoke flues; in the employment of a hinged or removable jacket around the base of the goose neck; in the arrangement of the ventilating pipes within the sides of the jacket or casing, and, in combination therewith, in the arrangement of the traps or doors upon and within the upper side of said casing; and, finally, in the general construction and arrangement of the heating and ventilating devices and of the casing.

114,802—May 16, 1871. JOHN GRACIE. *Improvement in stills for hydrocarbons.*

Claims surrounding a still for hydrocarbon with an air chamber and combining therewith an air pump.

156,223—October 27, 1874. THOMSON McGOWAN. *Improvement in oil stills.*

Claims a still for distilling hydrocarbons, and other liquid similar substances, having an elongated bottom, extending through and below the fire in the furnace, and communicating with a receiver or pit, for collecting the tar and residuum.

225,635—March 16, 1880. PIERRE NICOLAI. *Apparatus for distilling oil.*

Claims a receiver provided with a double casing and a double-cased projection communicating with each other, in combination with a steam coil, in communication with the casing of the said projection.

231,280—August 17, 1880. GERARD CRANE. *Oil still.*

This invention consists in a novel arrangement of a small still within a larger or main still and another small still outside of said main still, and a novel combination and arrangement of devices employed in connection therewith, whereby the process of distilling the oil is facilitated and hastened by enabling the oil to give off the more volatile products of distillation at the same time that the heavier products are being given off, and by means of the same fire for all of said stills.

231,420—August 24, 1880. HERMAN FRASCH. *Apparatus for fractionally condensing oil vapor.*

Claims in an apparatus for fractionally separating oils from vapors of the same, the combination, with a condenser, of a bath capable of sustaining a constant temperature above 212° Fahrenheit, and a duct for drawing off and separately collecting the product condensed by the temperature of said bath.

275,589—April 10, 1883. ROLLIN C. CLARK AND WILLIAM F. BEECHER. *Process of distilling petroleum*

Claims the combination, with a still located in a closed chamber and completely surrounded by air, of means to heat the air of said chamber.

314,490—March 24, 1885. JOSHUA THOMAS. *Apparatus for refining oils.*

Claims a stationary oil still surrounded by a hollow steam jacket, in combination with a steam heating coil in the lower part of said still, but discharging externally thereto, said still being closely incased in masonry.

318,698—May 26, 1885. ROLLIN C. CLARK AND MURRAY H. WARREN. *Still and filter.*

Claims in an oil still, the combination, with a heating chamber and a still located therein, of a heat generator located within an air chamber and communicating directly with said heating chamber, a hot-air flue leading from said air chamber, and a chimney in open relation with the heating chamber.

339,546—April 6, 1886. JAMES B. GRANT AND ALLAN MASON. *Apparatus for refining oil.*

Claims in an apparatus for refining oils, the combination, with a retort, and a connected condenser and vacuum pump, of an oil pipe having its exit end arranged within the retort, and an acid reservoir having an acid pipe similarly arranged, and having its exit closely adjacent to that of the oil pipe, whereby the stream from either pipe is impinged directly upon that of the other.

546,018—September 10, 1895. KARL LÖFHJELM. *Apparatus for distilling tar and refining turpentine.*

Claims the combination of tar still, turpentine still consisting of a jacketed turpentine holding tank, tar receiver connected with the tar still by a pipe descending from the tar still thereto, and condenser for the wood gases, said tar still and tar receiver connected with the jacket of the turpentine still for conducting the wood gases thereto, and said condenser connected with said jacket of the turpentine still for receiving the gases therefrom.

Subclass 12.—Rotary.

21,921—August 2, 1859. WILLIAM T. BARNES. *Improvement in apparatus for generating coal oil.*

Claims the arrangement of levers and rod, whether operated by a cam or otherwise, for the purpose of forming an automatic dust clearer to coal oil retorts.

27,327—February 28, 1860 FRANKLIN W. WILLARD. *Improvement in apparatus for distilling coal oil.*

Claims the arrangement of a series of valves and ports, in combination with a revolving retort, so operating as to always leave open one or more of the said ports at the upper portion of the retort and keep the remaining ports at the lower portion thereof closed.

27,503—March 13, 1860. FRANKLIN W. WILLARD. *Improvement in apparatus for distilling.*

Claims the method of distilling and evaporating liquids, consisting in the employment of a revolving still provided within its interior with a series of buckets, whereby while the still is maintained at a uniform temperature the liquid which is to be acted upon is kept in motion, and portions of the same successively separated, taken up, and returned to the mass in thin films.

37,793—March 3, 1863. J. L. ALBERGER. *Improvement in apparatus for distilling coal oils.*

Claims the employment simultaneously within an oil distilling retort of a steam supplying and a steam heating system of pipes.

48,672—July 11, 1865. CARLOS F. FREDERICI. *Improved apparatus for distilling.*

Claims a distilling apparatus composed of a series of hollow drums (two or more) connected by oblique pipes and provided with gudgeons on which it revolves.

91,448—June 15, 1869. JAMES J JOHNSTON. *Improved apparatus for distilling hydrocarbon oils.*

Claims distilling hydrocarbon oil by distributing it, through the medium of a pipe, in small jets or streams, against the inner surface of a revolving still, in which is placed a revolving shaft, armed with a spiral flange, so arranged that it will force the vapor evolved from the hydrocarbon from the still into the condenser.

148,800—March 24, 1874. WILLIAM J. BRUNDRED. *Improvement in oil stills.*

Claims a double revolving still, with steam chamber in combination with stationary steam pipes.

552,455—December 31, 1895. EDUARD THEISEN. *Apparatus for evaporating or distilling liquids.*

Claims in apparatus for evaporating or distilling, the combination with a drum and means for supplying material to the interior thereof at one point, of a mechanical scoop entering the drum and withdrawing the residual liquid therefrom at a point removed from the point of supply, means for revolving the said drum at a speed sufficient to cause, by centrifugal force, the material to travel over its interior surface in a thin film, from the point of delivery to the point of discharge, and an external means of heat impinging upon the surface of the drum.

552,456—December 31, 1895. EDUARD THEISEN. *Apparatus for evaporating or distilling liquids.*

Claims in apparatus for evaporating or distilling liquids the combination of two or more concentric revolving drums, means for heating the outer surface of the outer drum, means for supplying liquid to the inner surfaces of all the drums so as to travel in a thin layer over the said surfaces in order to be evaporated by the heat transmitted through them, means for removing the residual liquid from one or more of said drums after it has passed over the surfaces of said drums, and means for withdrawing the portion of the liquid separated by evaporation when condensed.

610,593—February 14, 1899. FREDERICK WILLIAM MANN. *Apparatus for distilling petroleum.*

Claims a petroleum distilling apparatus, comprising a closed vessel having a portion thereof adapted to be heated, a partition within the vessel lying close to such heated surface, means for introducing a petroleum spray into the space between said partition and the heated surface of the vessel, and means for maintaining a uniform pressure in said vessel.

Subclass 13.—Series.

27,842—April 10, 1860. D. S. STOMBS AND JULIUS BRACE. *Improvement in distillation of coal oil.*

Claims the apparatus consists of three retorts heated independently of each other, in order to be heated respectively to various degrees of temperature. Tubes extending down near to the bottom of the retorts in which they are respectively arranged, are closed at the bottom but open at the top, and serve as thermometers, by means of which the temperature in each of the retorts is indicated. The first retort is furnished with a pipe leading into the upper part through which the crude oil is to be supplied to the apparatus. At the opposite end and lowest part of the said retort is connected a pipe, the other end of which is connected to the next retort, at a point somewhat above its middle line. In like manner from the opposite lower extremity of this retort a pipe leads to the third retort. The last retort is provided with a similarly arranged pipe, leading from the bottom of said retort.

53,052—March 6, 1866. PETER H. VAN DER WEYDE, M. D. *Improvement in stills for petroleum.*

Claims the combination of three, four, or more stills, in single furnace in order to obtain with a single fire, and one single operation all the different volatile products of the petroleum—namely, lubricating oil, kerosene, benzine, naphtha, or gasoline.

53,359—March 20, 1866. AUGUSTUS H. TAIT AND JOSEPH W. AVIS. *Improvement in distilling apparatus.*

Claims the arrangement of a series of retorts, set horizontally alongside of each other over and across the fire flue, with the breadth of the fire grate nearly equal to the length of the retorts, the furnace being placed at one and the chimney at the other end of the series.

53,359—March 20, 1866; reissue 4,866—May 2, 1871. AUGUSTUS H. TAIT AND JOSEPH W. AVIS. *Improvement in apparatus and processes of distilling petroleum and other oils.*

Claims the process of continuous distillation consisting in causing the oil to flow through a series of retorts arranged over an arch or flue, so that the oil enters at the coldest portion of the series and leaves at the hottest portion.

53,512—October 2, 1866. PETER H. VAN DER WEYDE. *Improved double still for petroleum.*

The smaller still is placed outside of the first on the flue, thus economizing heat, and giving the second still a sufficient amount, but always a little less than that received by the first still. It is placed so much higher than the first that its bottom is equal with the surface of the oil in the first still when filled, connecting them with tube and stopcocks.

The condensers are placed as low as practicable—the bottom of the first condenser being only about four inches above the surface the oil has to reach in the second still, and the bottom of the second condenser about four inches above the level of the surface of the oil in the first still when filled.

A short, wide goose neck with dome attached, well protected for cooling influences by a felt covering, and connected by means of a slightly descending tube with the condensing worm, is employed.

63,115—March 19, 1867. A. H. TAIT AND JOSEPH W. AVIS. *Improvement in apparatus for distilling petroleum, etc.*

Claims a double still in which all the defects and objections against other double stills are corrected in the manner described.

This invention relates to a distilling apparatus which consists mainly of a still divided by one or more partitions into two or more compartments, which communicate with each other at the top by suitable openings for the vapors and at the bottom by openings for the liquid. The opening or openings in the top are provided with gates or cocks to shut off the communication and divide the light from the heavy vapors, so as to pass each into its appropriate condenser. The crude oil is admitted to that compartment farthest from the fire, and the compartment or compartments next to the fire are provided with valves or gates, so that the communication between the same and the preceding compartment or compartments can be cut off, and the compartment or compartments over the fire can be cleaned without being compelled to empty the entire still. The first and last compartments of the still are connected by a pipe which serves to equalize the gravity of the liquid contained in said compartments whenever it may be desired. The last compartment of the still connects with the coking retorts, in which the refuse or heaviest parts of the oil are subjected to a final distillation.

71,156—November 19, 1867. ANDRE FOUBERT. *Improvement in apparatus for distilling.*

The nature of my said invention consists in such an arrangement of pipes and cocks, applied in connection with two stills, that the vapor and water of condensation that pass off from one shall be utilized and employed in warming up the mash or wine in the other still, previous to commencing the distilling operation, thereby effecting a saving both of time and heat, as the fresh charge, supplied alternately to the stills, is brought to nearly a boiling point by steam that has heretofore been wasted.

78,878—June 16, 1868. ARTHUR KIRK. *Improvement in distilling petroleum.*

Claims effecting a continuous distillation of petroleum, or other distillable substances, by causing it or them to flow through a succession of stills, giving off in each still the more volatile ingredients, the stills being connected by trap pipes so as to prevent the backward flow of the substance to be distilled.

101,864—March 29, 1870. SAMUEL A. HILL AND CHARLES F. THUMM. *Improvement in stills for hydrocarbons.*

Claims a series of stills connected together by pipes which connect with zigzag ways or channels made in or on the bottom of each still, each still of the series being provided with a goose neck and condenser.

101,865—March 29, 1870. SAMUEL A. HILL AND CHARLES F. THUMM. *Improvement in stills for hydrocarbons.*

Claims a still divided into a series of compartments, the bottom of each compartment being provided with zigzag ways or channels, the compartments communicating with each other, and provided with a goose neck and condenser.

102,819—May 10, 1870. SAMUEL A. HILL AND CHARLES F. THUMM. *Improvement in apparatus for distilling hydrocarbon oils.*

Claims the combination and arrangement of a series of stills, so arranged with relation to each other that the flow of hydrocarbon through one or more of the stills of the series may be cut off from the other stills of the same series, and each still of the series being furnished with separate fire chamber, so as to apply a different degree of heat to each still.

135,678—February 11, 1873. AUGUSTUS H. TAIT AND JOSEPH W. AVIS. *Improvement in stills for petroleum and other liquids.*

Claims the arrangement in a still of partitions made in sections, the lower sections being made movable by means of hinge joints or slides, or otherwise.

136,008—February 18, 1873. EMIL SCHALK. *Improvement in oil stills.*

Claims a still for securing the distilled products of petroleum, consisting of a retort having a large passage from side to side, a lower chamber, an upper chamber, vertical chambers, and vertical tubes, all arranged as set forth.

136,008—February 18, 1873; reissue *5,988—July 28, 1874.* EMIL SCHALK. *Improvement in oil stills.*

Claims the combination with an oil still having oil inlet at the bottom and gas outlet at the top of a heating chamber, placed between the top and bottom of still and having spaces around the same.

154,772—September 8, 1874. SAMUEL VAN SYCKEL. *Improvement in apparatus for distilling hydrocarbon oils.*

Claims in combination with a primary still or stills and the final still or stills, intermediate still or stills, having transfer and vapor connections for the purpose of equalizing the temperature of the liquid between the primary and final stills.

172,131—January 11, 1876. EDWARD LANE. *Improvement in oil distilling processes and apparatus.*

Claims the continuous process for fractionally distilling or refining crude petroleum by direct heat, consisting in the following successive steps: First, heating the crude oil and at once withdrawing the free water; second, distilling off the lighter oils, and at the same time withdrawing further water; and, third, subjecting the remaining oil to successive heatings alternated with evaporations and condensations at successively high temperatures, wherein the oil is prepared by heat for each evaporation.

182,169—September 12, 1876. JAMES COLE, JR. *Improvement in apparatus for the separation of petroleum products.*

Claims the combination, with a still provided with a vapor outlet, of perforated steam pipes for applying heat to the contained liquid, and an independent blast pipe for introducing within the still a current of air or steam.

220,562—October 28, 1879. JAMES COLE, JR. *Improvement in apparatus for distilling petroleum.*

Claims the combination, with a primary still, primary condenser, secondary still, and pipe which passes through said condenser and opens into the secondary still, of an independent pipe, connecting the secondary still with the primary still.

311,368—March 24, 1885. RICHARD DEAN. *Apparatus for the distillation of hydrocarbons.*

Claims a still for distilling hydrocarbon oils, and provided with a crown sheet, and inner and outer plates extending below the body of the still, forming hollow so-called legs that extend the length of the still, and one or more fire boxes located between the legs and under the crown sheet, one or more feed pipes leading into the leg on one side, and a discharge pipe connected with the opposite leg, and the parts so arranged that a continuous flow of oil is had through the still and maintained at a uniform depth by the elevation of the discharge pipe.

340,878—April 27, 1886. NORMAN M. HENDERSON. *Apparatus for distilling or refining mineral oils.*

Claims the combination of a still and its inlet and outlet pipes, having the usual stopcocks outside the still, with weighted valves applied to the said pipes within the still, and having handles extending to the outside.

342,500—May 25, 1886. RICHARD DEAN. *Apparatus for distilling hydrocarbon oils.*

Claims for the fractional distillation of hydrocarbon oils, a series of stills forming a plant, each of said stills consisting of a steam-tight cylinder having therein an oil-eduction pipe and induction oil tubes, the lower ends of which tubes terminate in an oil chamber in the lower end of the next succeeding cylinder, and the upper ends of the tubes and the upper end of said oil-eduction pipe terminating in a vapor chamber in the upper part of the cylinder, said chamber being in communication with a deodorizing chamber provided with a vapor-discharging pipe, oil-feed pipe terminating in the lower chamber of the cylinder, with a steam pipe arranged to induct steam into said cylinder, and a pipe for exhausting steam therefrom.

374,838—December 13, 1887. EDWARD KELLS. *Distilling apparatus.*

Claims in a distilling apparatus, the combination, with primary and secondary stills, of a system of connected pipes consisting, essentially, of an escape pipe leading from the primary still through a separator, substantially as indicated, a pipe leading to the secondary still for the passage of heavier distillates, and a pipe connected to the escape pipe for the discharge of lighter distillates, the latter being carried to a considerable elevation above the said return pipe.

444,203—January 6, 1891. ALLAN MASON. *Apparatus for distilling oil.*

Claims the combination, in a still for continuous fractional distillation, of the continuous pipe retort, comprising a series of successive chambers, each having the oil inlet and a steam injector at the receiving end impinging the steam jet directly on the entering stream of oil, so as to instantly atomize it in one body and project the same along the chamber to the opposite end, and each section having a vapor exit and an oil exit thereat, through which the vapor and oil respectively escape, the one to the condenser and the other to the next section of the retort, the arrangement being such that all of both of the vapor and the unvaporized oil have like exposure as to heat and time in the respective sections of the retort, the furnace underneath said pipe retort made in separate sections, each containing a section of the retort, the flues at the opposite extremities of the chambers and the passages and dampers causing the regular or irregular traverse of the heat products through the successive sections of the furnace.

478,365—July 5, 1892. HEINRICH PROPFE. *Distilling apparatus.*

Claims in an apparatus for distilling tars and mineral oils, the combination, with a train of stills, the adjacent ones of which have intercommunication between their lower parts, of a furnace at one end of the train and a flue running therefrom to the other end of the train, a feed pipe for feeding the still at the end of the train farthest from the furnace, and an exit pipe communicating only with the still nearest the furnace and running through the several stills of the train.

524,704—August 21, 1894. ROBERT A. CHESEBROUGH. *Apparatus for continuous distillation.*

Claims a still comprising several members in communication with each other at the top, each member being provided with oil-retarding plates and the member next succeeding a previous member being provided with a depending baffle plate at its top intermediate of the inlet and outlet passages, an oil-supply pipe and a superheated steam-supply pipe in communication with the first members, means for maintaining a reduced degree of temperature in succeeding members, suitable discharge pipes leading independently from the bottoms of the several members, a condenser and a pipe leading from the final member into the condenser.

546,697—September 24, 1895. PAUL DVORKOVITZ. *Apparatus for distilling liquid hydrocarbons.*

Claims apparatus for the double distillation of liquid hydrocarbon consisting of a furnace, three superheaters located side by side within said furnace, a steam generator connected with the intermediate superheater, a crude-hydrocarbon reservoir and a tar reservoir connected respectively with the other superheaters, two retorts, provided with means for heating them, a spray pipe leading from the intermediate superheater into both retorts, a spray pipe leading from each of the other superheaters to its corresponding retort, and a separate condenser for each retort.

556,412—March 17, 1896. CHARLES F. GRADY. *Apparatus for refining petroleum.*

Claims the combination with a still, of an oil supply pipe leading thereinto and connected with perforated longitudinally disposed pipes, a steam supply pipe entering the still and extended to a point near the bottom thereof and communicating with longitudinally disposed perforated pipes, a second still, a discharge pipe disposed longitudinally within the first still and having perforations upon its under side and leading into the second still and extended above the point of steam supply in said second still, and perforated longitudinally disposed pipes and branch pipes supported by the same.

567,752—September 15, 1896. ADOLPHE SEIGLE. *Apparatus for treating hydrocarbons.*

Claims in an apparatus of the character described, a series of vaporizing chambers and a series of superheating chambers containing inert material, an inlet to the first in series of said vaporizing chambers for the reception of the hydrocarbon and an outlet from the last in the series of vaporizing chambers communicating directly with each superheating chamber, both series of vaporizing and superheating chambers being immersed in a bath of molten metal, all arranged so that the hydrocarbons are successively heated in the vaporizing chambers, and the vapor from the last in series of vaporizing chambers is conducted to each separate superheating chamber to be further heated.

728,257—May 19, 1903. MAX LIVINGSTON. *Apparatus for continuously distilling petroleum.*

Claims in an apparatus for continuously distilling petroleum the combination with a series of distinct and independent stills; of a series of pipe connections which unite said stills in a continuous series; said connections each comprising an oil outlet from one still and an oil inlet to another still; said outlet having a regulating section arranged to adjustably determine the liquid level in the still associated therewith.

731,943—June 23, 1903. WILLIAM D. PERKINS. *Apparatus for continuous fractional distillation of petroleum.*

Claims in an apparatus for continuous fractional distillation of petroleum and similar hydrocarbons, the combination of the vaporizer and a receiver for the unvaporized product, of condensers connected with said vaporizer, pipe coils or worms in the several condensers, which are connected in series, receivers for heavy unvaporized products connected with the several worms, a steam superheater and a pipe connecting it with two condenser appliances for the latter and the vaporizer, and thermostatic regulators for such heaters.

781,045—January 31, 1905. BENJAMIN F. BROOKE-SEWELL. *Apparatus for evaporating and distilling liquids.*

Claims in an apparatus for evaporating liquids the combination of two or more chambers or receptacles, means arranged in one chamber or receptacle for condensing the vapors generated therein and for transmitting heat developed during condensation to the liquid contained in the other chamber, means for collecting and carrying away the liquid formed by condensation, and means for removing solid matter deposited in the chambers or receptacles.

Subclass 14.—Tubulars.

82,568—June 18, 1891. EDWARD G. KELLEY AND AUGUSTUS H. TAIT. *Improvement in processes and apparatus for distilling, separating, and purifying petroleum.*

Claims the process for distilling hydrocarbon oils, consisting in flowing the oil in a stream through a series of retorts arranged so that the oil enters the retort in the cooler part of the furnace and is subjected to an increasing temperature as it flows, so that vapors of different densities are successively removed, and

A series of retorts or stills arranged in a furnace and connected together, so that oil may be distilled continuously by being fed into the retort or still in the colder part of the furnace, and flowing successively through the retorts in the hotter portions of the furnace, and thereby separating the different portions of oil according to the temperature at which they become vapor.

62,096—February 12, 1867; antedated January 30, 1867. P. H. VANDER WEYDE, M. D. *Improvement in tubular stills for continuous distillation.*

Claims a still, consisting of a series of tubes situated in the flue, through which tubes the liquid to be distilled is uninterruptedly passed in a small stream, and in its downward course submitted to a continual increased heat.

68,850—September 17, 1867. JOHN ELLIS AND EDWARD C. KATTELL. *Improvement in apparatus for distilling, evaporating, and refining oils and other liquids.*

Claims the construction of a retort, or a part of a retort, of a pipe or pipes, so arranged that when either steam or superheated steam and oil or other liquids are passed or forced through it, or them, in the same or in opposite directions, the fluid will naturally, from its superior gravity, repeatedly pass through the current of steam, thus thoroughly mixing it with the steam in a comparatively confined space, heating it uniformly and vaporizing it, as occurs in the tubular portion of our apparatus, and as will result if a spiral pipe is placed in a horizontal position, or approaching that position, and steam and oil passed through it.

87,207—February 23, 1869. CHARLES A. SEELY. *Improved apparatus for distilling and separating oils, fats, and the like.*

This invention consists in making the still in the form of a coil, the coil terminating at its lower end in a pipe, which moves upward, serves as a conduit of vapor to the condenser, and furnishing the coil, at its lowest point, with a tube leading downward, and serving to carry away the liquid which it is not desired to volatilize.

166,285—August 3, 1875. THOMSON McGOWAN. *Improvement in the distillation of hydrocarbon oils.*

Claims the combination, in an oil still of an elongated vessel, having a series of partitions, a steam pipe extending throughout the length of the vessel, and vapor pipes projecting from the elongated vessel.

182,775—October 3, 1876. HENRY C. ROSE. *Improvement in apparatus for distilling oil.*

This invention is an apparatus for distilling hydrocarbon oils, and it consists of a system of pipes arranged in a serpentine like manner over a furnace either longitudinally or transversely therewith. In connection with said system of pipes is arranged above them, and either parallel or transversely therewith, a system of vapor pipes, terminating in condensing coils or still worms. Said lower pipes are provided with perforated steam pipes.

215,756—May 27, 1879. JOSEPH L. KIRK. *Improvement in processes and apparatus for distilling petroleum.*

Claims in an apparatus for distilling crude petroleum, the combination of a continuous pipe through which the petroleum flows and in which it is evaporated, a series of pipes successively arranged for taking up the gases as evolved, a series of filters for purifying the gases of different density, and a series of branch pipes for mingling bleaching gases with those evolved and purified gases of petroleum, and

In the distillation of petroleum the process of clarifying and bleaching the same, which consists in vaporizing the petroleum by heat, and then passing the vapors through a filter, and subsequently mingling the vapors with the vapors of sulphuric acid or other bleaching vapors, and then condensing the petroleum vapors.

253,990—February 21, 1882. ERNEST F. DIETERICHS. *Apparatus for fractional distillation.*

Claims in an apparatus for distilling oil and other substances, the combination of a retort located in a suitable furnace and a distilling coil located in said retort with the steam supply and eduction pipes leading to and from the retort, the said pipes being connected with the retort and a suitable oil supply pipe, and provided with an injector for forcing the oil into the distilling coil.

282,239—July 31, 1883. JOSHUA THOMAS. *Oil still.*

Claims an apparatus for distilling or reducing petroleum by a continuous operation, consisting of a divided evaporating chamber, having low partitions and vapor outlets, a series of coupled pipes, arranged beneath said chamber and in an inclosed heating chamber provided with thin partitions, arranged to convey the heat alternately up and down between said pipes, a jacketed reservoir, connected by pipe to said heating chamber, and a pipe leading to chamber whereby the material to be treated is conveyed into said evaporating chamber and through the heated pipes in one direction, while the heat is conveyed in the opposite direction.

300,811—June 24, 1884. HENRY C. SMITH. *Apparatus for the continuous distillation of oil.*

Claims in an apparatus for continuous distillation of oil, pipes arranged in a plane inclined to the horizon at about an angle of forty-five degrees—one above the other—and provided with vapor outlets and connected at alternate ends with connections, and inclosed in a chamber, whereby said pipes operate for the distillation of the several gravities of oil products.

305,056—September 16, 1884. RICHARD DEAN. *Apparatus for distilling or reducing oils.*

Claims in an apparatus for distilling or reducing oils, the combination, with a series of lower stills, consisting of two or more horizontal pipes, and a series of upper stills, consisting of two or more horizontal pipes, the upper stills being connected with the lower stills by manifold branches, of oil conducting pipes connecting each upper still with the succeeding lower still, pipes connecting each upper still with a suitable vapor condenser, and steam pipes adapted to discharge free steam into each upper still.

361,671—April 26, 1887. DAVID P. BROWN AND JOHN W. NEELEY. *Apparatus for distilling.*

Claims in a retort furnace for distilling petroleum oils, adapted to supply suitable heat, the combination of a retort or series of retorts, suitably connected together, a steam pipe, entering each retort, extending through and sealed at one end, and provided with numerous small perforations, an oil pipe likewise entering each retort, extending through and sealed at one end, and provided with numerous small perforations, and another steam pipe, of like construction, extending into each oil pipe.

439,745—November 4, 1890. EVAN A. EDWARDS. *Apparatus for distilling oils.*

Claims in an apparatus for distilling oil, the combination, with a flue boiler, of a series of vaporizers arranged in the flues of the same, a steam and an oil supply pipe connecting therewith at one end, and a series of condensing traps connected therewith at the opposite end.

547,832—October 1, 1895. FRANK W. CLARK. *Distillation and breaking up of liquid hydrocarbons, and apparatus therefor.*

Claims the method or process of distilling and breaking up liquid hydrocarbons or similar substances, which method or process consists in causing the liquid to flow in numerous thin or shallow streams in one direction over the operative surfaces of an evaporator or retort, circulating a carrier such as air first in contact with heating surfaces and then over said streams of liquid in the reverse direction, and conveying the vapor therefrom by means of said carrier through a condenser and then conducting the carrier, together with any uncondensed vapor, from the condenser back into the evaporator or retort, the unvolatilized liquid in the evaporator or retort and the liquid of condensation in the condenser being drawn off as required.

567,751—September 15, 1896. ADOLPHE SEIGLE. *Apparatus for treating liquids.*

Claims in an apparatus a series of double walled sections, the interiors of which form a continuous combustion flue, the walls of the sections being separated to form a liquid chamber concentric with the flue and closed at either end of the section, a series of spiral partitions dividing the liquid chamber into a series of serpentine channels, a series of pipes each forming a means of communication between the liquid chambers of adjacent sections, and means for forcing oil through successive sections in a direction opposite to that in which the products of combustion pass through said sections.

640,202—January 2, 1900. HANS A. FRASCH. *Apparatus for continuous fractional distillation of hydrocarbons.*

Claims in a distilling column, consisting of a series of communicating shells, a manifold connected with alternate shells to receive the vapor from every two shells, and means for conducting away the separate vapors at several desired points to separate condensers; and a bottom shell having an open outlet and a vapor seal at the base of the column of shells.

737,766—September 1, 1903. WILLIAM MAYBURY. *Still.*

Claims in a still, a furnace, a continuous conduit therein formed from pipe sections, the ends of said sections extending through the walls of the furnace and provided with couplings, connectors between said couplings, and means in a portion of the couplings for creating a suction through the respective pipe sections, and for forcing the vapor or volatilized oil in said respective sections through said outlets, said means arranged to operate upon the volatilized portions only.

754,087—March 15, 1904. JAMES M. O'NEALL. *Apparatus for refining crude petroleum.*

Claims apparatus for refining crude oil comprising means for converting the volatile oil into vapor by heat, a receptacle for collecting and separating the vapor and the nonvolatile matter, a condenser for converting the vapor back to oil, and means for forcing the vapor into a fluid in the condenser.

779,898—January 3, 1905. ALBERT C. CALKINS. *Oil separator.*

Claims a separator provided with a series of pipes, a separate coupling connecting successive series of said pipes containing a seal or trap and having independent outlet connections, jackets on each of said pipes and means for simultaneously supplying different degrees of heat within said jackets, whereby different vapors are liberated within said pipes and the remaining liquid continues its course.

Subclass 15.—Utilizing Gases and Residue.

459,123—September 8, 1891. FREDERIC LENNARD. *Apparatus for the distillation of tar.*

Claims in an apparatus for distilling tar and like substances, the combination of a furnace or heater, a tank containing a liquid bath, a still immersed or partially immersed therein, a tower or scrubber, means for conducting the material to be distilled into the upper part of the scrubber, a connection between the lower part of the scrubber and the still, a steam pipe leading into the lower part of the scrubber, and conduits which lead off the vaporous products rising into the upper part of the scrubber.

Subclass 16.—Vacuum.

34,324—February 4, 1862. HERBERT W. C. TWEDDLE. *Improved apparatus for distilling coal oil and other substances.*

Claims the use of a vacuum apparatus in combination with a steam pipe arranged in the interior of the still.

34,324—February 4, 1862; reissue 2,404—November 27, 1866. HERBERT W. C. TWEDDLE. *Improved apparatus for distilling coal oil and other substances.*

Claims the use of superheated steam, in combination with the employment of a vacuum or partial vacuum, for the distillation of petroleum and other hydrocarbon oils and similar substances.

46,688—March 7, 1865. EDWARD BRAGGINS. *Improved apparatus for distilling petroleum, etc.*

Claims a method of producing a vacuum in a condenser by water.

47,126—April 4, 1865. JAMES PERKINS AND WILLIAM H. BURNET. *Improved apparatus for refining and distilling petroleum.*

Claims the combination of two receivers with an agitator and a sediment receiver; and,

The use of two exhaust pumps in combination with a distilling and condensing apparatus described.

48,285—June 20, 1865. JAMES J. JOHNSTON. *Improved apparatus for distilling oil.*

Claims distilling oil or other liquids by means of a still, condenser, and receiving vessel, from which oil is exhausted, so that the distilling process is carried on under a partial vacuum.

50,571—October 24, 1865. HUOT FLEURY. *Improvement in distilling petroleum.*

This invention consists in the distillation of petroleum oil by a vacuum and its rectification by one single operation.

54,157—April 24, 1866. ABRAM D. HIGHAM. *Improvement in distilling petroleum.*

Claims distilling the lighter portions of the charge in vacuo and the heavier portions under pressure.

56,852—July 31, 1866. M. P. EWING. *Improvement in apparatus for distilling petroleum.*

Claims the combination of a continuous feed and a jet condenser with a vacuum still for petroleum.

58,020—September 11, 1866; reissue 7,322—September 26, 1876. Division B. VACUUM OIL COMPANY. *Improvement in material for lubricating.*

Claims the process of making residual heavy hydrocarbon oil without burning by distillation of the light oils from crude petroleum under vacuum with steam.

58,021—September 11, 1866. M. P. EWING AND H. B. EVEREST. *Improved apparatus for distilling petroleum, etc.*

This invention consists essentially in certain improvements to prevent overflowing in vacuum stills for petroleum by introducing jets of steam into and through the mass of oil in the still, and by the arrangement of the heating pipes in close proximity, so as to lessen the amount of oil in the retort as compared with the heating surface, and the employment of an overflow chamber, and conducting the overflowing material to a receptacle, thereby preventing its admixture with the distilled product; also, in the combination of a surface with a jet condenser for the oil vapor.

62,780—March 12, 1867. EDWARD DUNSCOMB. *Improvement in vacuum pumps, pans, etc.*

Claims an air induction pipe with its stopcock applied to an air-tight tank.

68,426—September 3, 1867. HIRAM B. EVEREST. *Improvement in apparatus for distilling petroleum.*

Claims the combination of two or more vacuum petroleum stills, so arranged that the oil is fed from one retort into the other as it increases in specific gravity during the distillation, and economizing the use of steam used in the vaporization of the oil in the retorts, by passing it first through the heating pipes in the retort containing the heavier oils, and afterwards conducting it through the heating pipes in the retort or retorts containing the oils of lighter specific gravity.

77,070—April 21, 1868. JAMES MILLER. *Improved apparatus for distilling petroleum.*

Claims the combination of two or more vacuum stills, one for heating the oil, and driving off its more volatile ingredients, and the other for carrying on a continuous distillation, by feeding therein the heated oil from the first still through a coiled or zigzag pipe with apertures.

89,988—May 11, 1869. HENRY GROGAN AND GEORGE T. LAPE. *Improvement in the distillation of hydrocarbon oils.*

Claims the application of cold hydrocarbon oils to a heated still, in such quantities that the heat in the still will suddenly evolve their available products, or so much of them as may be desired, before admitting a subsequent supply.

300,185—June 10, 1884. HOMER T. YARYAN. *Apparatus for vacuum distillation.*

Claims in a vacuum distillation apparatus, the combination of a coil surrounded by steam or other heating medium, a separating chamber, a vacuum pump and pipe connections.

374,077—November 29, 1887. JEAN A. MATHIEU. *Apparatus for separating substances which volatilize at different temperatures.*

Claims the combination of a vacuum pan having interior heating coils, and with atomizer devices for spraying liquid material into the vacuum pan above the trays.

Subclass 17.—Vapor Outlets.

16,255—December 16, 1856. RICHARD SHRODER. *Improvement in apparatus for coal oil.*

Claims constructing the retort or generator with openings at different heights for the purpose of obtaining oil of different qualities.

40,632—November 17, 1863. CHARLES LOCKHART AND JOHN GRACIE. *Improvement in stills for petroleum, etc.*

This invention relates, first, to a means for taking off vapor from the still at the same height from the surface of the oil and at different heights during the process of distillation; second, to a means for keeping the bottom of the still clean or free from incrustation.

40,632—November 17, 1863; reissue 3,002, June 23, 1868. CHARLES LOCKHART AND JOHN GRACIE. *Improvement in stills for petroleum, etc. Division A.*

Claims providing a still used for distilling hydrocarbon with a scraper or scrapers, combined with a receiving device, said scraper or scrapers being rotated during the process of distillation, and operating with relation to the bottom of the still and said receiving device.

40,632—November 17, 1863; reissue 3,003, June 23, 1868. CHARLES LOCKHART AND JOHN GRACIE. *Improvement in stills for petroleum, etc. Division B.*

Claims a still provided with a pipe or pipes which is or are so arranged with relation to the still and its contents that the vapor evolved from the contents of the still can be conveyed off at different heights.

105,683—July 26, 1870. JOHN HOFFERBERTH. *Improvement in oil still.*

The nature of this invention consists in providing an oil still with a short worm, for the purpose of allowing gasoline and other inflammable products of distillation to escape without combining with the refined oil; also, in connecting the long worm at a point below the top of the still, and providing a means for preventing the oil from ascending higher than such point of connection.

113,811—April 18, 1871. JOHN L. STEWART AND JOHN P. LOGAN. *Improvement in petroleum stills.*

Claims a still with its top in the form of an annular corrugation, in combination with a series of pipes so arranged as to draw off the vapor from the still at the highest part of the said corrugation.

237,560—February 8, 1881. MAX LIVINGSTON. *Oil still.*

Claims an oil still having a vapor-escape passage opening into and extending above the top of the still chamber, in combination with a succession of valve-governed vapor-escape passages, leading off from the side of the still chamber at different points in its height.

243,080—June 21, 1881. CHARLES T. PLACE. *Distillation of petroleum and other oils.*

Claims the combination of a still and goose neck, the latter of which is provided with ascending and descending pipes or branches, the descending pipe or pipes passing through the still or other heating chamber.

266,990—November 7, 1882. WILLIAM C. HALL. *Apparatus for separating petroleum vapors.*

Claims the combination of a still, a vertical pipe, secured to the top thereof, a series of pipes connected at different heights to the vertical pipe and united together again at a distance from the still, with a steam pipe connected with the uppermost pipe, cocks and traps upon the lower pipes, leading from the still.

284,331—September 4, 1883. DAVENPORT ROGERS. *Self heating and separating still.*

Claims an apparatus for distilling petroleum, consisting of a heater, a coil of pipe arranged within said heater and connected with the source of supply of the petroleum to be distilled, a still, a pipe leading from the coil into the still to supply petroleum to said still and maintain a shallow body of oil in said still, a trap between the heater and still to eliminate the water from the petroleum before the petroleum enters the still, pipes leading from the still back into the heater to convey the vapors from the still to the heater, wherein such vapors serve to preheat the petroleum in the coil, graded eduction pipes for separating the vapors in the heater and taking off such vapors according to their gravity, and a pipe leading from the heater to the still furnace to enable the utilization of the incondensable gases as fuel, all combined and arranged to operate, whereby cold crude material is preheated by the vapors coming from the still, and such vapors separated according to the gravity and a continuous and constant distillation kept up.

Subclass 18.—Supplementary Heating.

50,276—October 3, 1865. JOHN ROGERS. *Improvement in stills for distilling petroleum.*

Claims the process of distilling petroleum or other hydrocarbon liquids by passing the crude oil through heated pipes or their equivalents in the interior of the still, for the purpose of freeing the same from their most volatile constituents.

54,218—April 24, 1866. H. A. SCHESCH. *Improvement in apparatus for distilling.*

Claims exposing the upper part or vapor space of a still to the action of an additional fire built in a secondary fireplace.

61,474—January 22, 1867. JOHN S. SHAPTER. *Improvement in petroleum stills.*

Claims the arrangement of boiler, superheater, and still, by which the heat from the boiler is made to pass through the superheater, and then through, under, or around the still.

90,284—May 18, 1869. JOSHUA MERRILL. *Improved manufacture of deodorized heavy hydrocarbon oils.*

This invention consists in producing heavy hydrocarbon oils, suitable for lubricating and other purposes and free from the characteristic odors of heavy hydrocarbon oils, by distilling from them the volatile matters from which the objectionable odors arise, and at the same time preventing new formations of such matters by keeping the temperature of the oil in the still below that at which these matters form by decomposition of the oil.

90,284—May 18, 1869; reissue 7,733, June 12, 1877. JOSHUA MERRILL. *Improvement in processes and apparatus for the manufacture of deodorized heavy hydrocarbon oils.*

Claims the mode of manufacture of deodorized heavy hydrocarbon oils, which, when finished, are distillates suitable for lubricating and other purposes, free from the characteristic odors of hydrocarbon oils, and having a slight smell like fatty oil, by distilling from them the volatile matters from which the objectionable odors arise and preventing the formation of such matters by keeping the temperature of the oil in the still below that at which these matters form by decomposition of the oil.

90,284—May 18, 1869; reissue 7,826, July 31, 1877. JOSHUA MERRILL. *Improvement in the production of deodorized heavy hydrocarbon oils.*

Claims heavy hydrocarbon oil, suitable for lubricating and other purposes, free from the characteristic odors of hydrocarbon oils and having a slight smell like fatty oil.

94,409—August 31, 1869. HENRY GROGAN. *Improved still.*

Claims a hot water condenser in combination with a suspended drum pipe and goose neck of the still, whereby the water in said condenser is heated by means of the steam discharged from the drum.

110,806—January 3, 1871. WILLIAM G. WARDEN. *Improvement in apparatus and processes for distilling oil.*

Claims the process of distilling oils, etc., by subjecting the same to the action of heat in a vessel a portion of which extends below the fire and in which a constant upward current from the said lower portion is maintained.

123,741—February 13, 1872. JOHN STUBER, JACOB STUBER, AND JOHN W. MAGER. *Improvement in distilling petroleum.*

Claims the process for producing continuous distillation of petroleum by means of supply tanks, the contents of which are heated before they are injected into the still, and which connect with a double acting pump by which a continuous supply of the heated liquid from the supply tanks is driven into the still, while the still is placed over a furnace for the purpose of keeping up the temperature of the liquid contained therein and injected into the same by the action of the pump.

218,091—August 26, 1879. JOSEPH C. ROBINSON. *Improvement in oil stills.*

The present invention has relation to that class of stills used for the purpose of manufacturing lubricating, illuminating, and other oils; and it consists in providing the feed pipe for oil with jackets near the top and bottom of the still, inclosing said feed pipe and steam pipes connecting the jackets, the steam pipes also having connection with the interior of the still, to which exit pipes for the steam are attached, the still, with its appurtenances, being also subjected to the action of fire heat, whereby a rapid and continuous distillation is effected, and the incoming oil warmed by exhaust steam before entering the still.

289,471—August 21, 1883. JOHN B. DUBLER. *Oil still.*

Claims, in an oil still, a boiler provided with the supplemental boilers extended down into the fire chamber and connected to the main boiler, and with a dome or domes, provided with a nipple plate, a support and resistance plates arranged therein, with a pipe leading from said boiler and dome.

342,565—May 25, 1886. GEORGE L. BENTON. *Apparatus for refining crude petroleum.*

Claims the combination with a furnace, of a heating chamber, a latent vaporizing pipe connected with an oil supply and situated within the furnace, a vapor chamber located above the furnace and directly heated thereby, and a condenser.

499,557—June 13, 1893. FREDERIC LENNARD. *Method of and apparatus for distilling tar, etc.*

Claims the process of distilling tar or the like, consisting in heating it while confined in coils or passages, to a degree which would cause its required constituents to vaporize if not thus confined, and causing the said tar or the like so heated to enter and its said constituents to vaporize in a scrubber into which steam or other disassociating agent is admitted.

SUBCLASS 19.—COAL OIL RETORTS.

16,645—September 2, 1856. CUMMINGS CHERRY. *Improvement in apparatus for distilling crude oil from mineral coal.*

Claims providing upright retorts for the manufacture of oil from bituminous coal with a closed top and an opening at their bottoms to be immersed in water.

22,407—December 28, 1858. LUTHER ATWOOD. *Improvement in apparatus for destructive distillation.*

Claims the combination and arrangement of a distilling tower and receiving vessel, with a steam blast or its equivalent in the combination, for the purpose of producing an induced current.

22,573—January 11, 1859. JAMES O'HARA. *Improvement in retorts for distilling oils from coal.*

Claims the employment, in an upright retort for distilling coal, of a revolving screw of a circumference smaller than the interior of the retort, so applied that while by its revolution it produces a continuous elevation of the central portion of the charge it permits and causes a continuous descent of the surrounding portion by gravitation, and thus produces a positive continuous and uninterrupted upward and downward circulation.

22,738—February 1, 1859. NATHANIEL B. HATCH. *Improvement in retorts for distilling coal oil.*

Claims the application and use in retorts used in distillation of coal or other substances from which oil or gas is producible, of a sweep bar or arm with plates attached, and operated so as to push or spread the material placed within over the floor or bottom, and at intervals discharge the same continuously in openings at or near the edge of the retort.

23,006—February 22, 1859. LUTHER ATWOOD. *Improvement in apparatus for destructive distillation.*

This invention consists in combining a vertical combustion tower or fireplace, open at the top, and in which fuel is burned with a downward draft, with a vertical distilling tower or chamber, in which the substance acted on is placed, and with a continuous strain blast or other controllable means of producing a draft through the apparatus in such manner that the products of combustion from the combustion tower enter the distilling tower at the bottom and pass up through it and the mass of fragments it may contain.

23,337—March 29, 1859. LUTHER ATWOOD. *Improvement in apparatus for destructive distillation.*

This invention consists in combining a vertical distilling tower, or chamber, arranged so as to receive both the fuel and the substance operated on, with a condenser and a means of controlling or regulating the draft, by which the products of combustion of the fuel are circulated through the mass acted on, so that the process of decomposition can be carried on below a temperature that would effect combustion before the liquid and volatile products have been driven off by the heat, the whole apparatus being so arranged and combined as to use the current of products in its natural or upward direction.

24,211—May 31, 1859. ROBERT W. HAZLETT AND JOHN H. HOBBS. *Improvement in retorts for distilling coal oil.*

Claims constructing a horizontal retort with a pan or flat-shaped base and inclined upper sides or top, and with open conduits or gutters running from end to end of the retort, and arranged on the inner sides thereof and set inclining and emptying into the neck of the retort.

24,212—May 31, 1859. J. E. HOLMES. *Improvement in retorts for distilling oil from coal.*

Claims the employment, in a retort for distilling oil from coal, of a central perforated tube suspended from the mouthpiece, an open space being also left below the bottom of the tube for the removal of the coke residuum through the mouth.

26,000—November 1, 1859. H. K. SYMMES. *Improved apparatus for distilling coal.*

Claims an oil retort in combination with the gas retort or its equivalent for the purpose of saving the gas which escapes from the oil retort and to improve its quality.

27,603—March 20, 1860. C. I. VAN WYCK. *Improvement in apparatus for distilling oil from coal.*

Claims the construction of a retort with a grate in the bottom, and an inclined conductor below such grate, such conductor not being the outlet for the gaseous products of combustion of the fire by which the retort is heated.

32,373—May 21, 1861. GEORGE W. KIRCHHÖFFER. *Improvement in apparatus for distilling coal oil.*

Claims, in combination with an upright conical retort, a grinder arranged to rotate in proximity with the heated surface of the retort, for the purpose of pulverizing the coal and securing the contact of the same in a minutely divided state with the heated surface of retort.

34,195—January 21, 1862. JOHN BULLARD. *Improvement in apparatus for distilling coal oil.*

Claims an egg-shaped retort, arranged with draft opening at its lower end, so that the unburned contents of the retort will always be within the lines of the draft.

42,772—May 17, 1864. JOHN HOWARTH. *Improvement in apparatus for distilling off gases and vapors.*

Claims so combining devices for superheating steam, flues for the passage of products of combustion, and a suitable retort or retorts containing carbonaceous materials as to cause the internal heat, or that produced by the superheated steam, to always predominate over the external heat and perform the work of extracting the liquid and volatile products from the retort or retorts without producing destructive distillation.

458,886—June 2, 1891. GEORGE POTERIE. *Apparatus for producing coal tar and coke.*

Claims, in a plant for producing coal tar and coke, the combination of a series of ovens, the retorts arranged above said ovens and adapted to be heated thereby, a receiving vessel adapted to be partly filled with water and arranged below the ovens and connected individually with the retorts, the pipe in the top of said vessel, and a boiler intermediate of said ovens and the receiving vessel, a pipe in the boiler adapted to discharge steam in the pipes leading from the retorts, and a pipe leading from the receiving vessel to the furnace of the boiler to convey gas thereto.

759,988—May 17, 1904. SNYDER L. HAGUE. *Retort.*

Claims an apparatus for extracting oil from shale comprising a horizontal retort, a furnace beneath one end of said retort, a series of connected flues extending beneath said retort from the furnace to a smoke vent, air valves in said flues, a revolving conveyor to move the shale from the cooler to the hotter end of said retort, and a steam jet to drive the vapors from the hotter toward and out through a vent in the cooler end of the retort.

775,448—November 22, 1904. SNYDER L. HAGUE. *Retort.*

Claims, in a horizontal retort for extracting oils from shale and heated to graded temperatures by a suitable furnace, a conveyor to turn the shale over and move it along the retort from its cooler to its hotter end, cross partitions in said retort above and partly around said conveyor, and inlet and outlet pipes connecting with the apartments formed by said partitions.

Subclass 20.—Coal Oil Retort, Rotary.

20,026—April 27, 1858. DAVID ALTER AND SAMUEL A. HILL. *Improvement in revolving retorts for distilling coal, etc.*

Claims the use of retorts so constructed as to revolve continuously on their axes during the process of distillation.

10,026—April 27, 1858; reissue 663—February 8, 1859. D. ALTER AND S. A. HILL. *Improvement in distillation of oils from coal.*

Claims the destructive distillation of coal or other bituminous substances for obtaining the liquid products thereof in the form of what is known as "coal oils" by combining the use of a low temperature, not exceeding a low red heat, say about 850° Fahrenheit, with the use of retorts so constructed as to have a rotary or other equivalent motion for the purpose of agitating their contents.

20,587—June 15, 1858. T. D. SARGENT. *Improvement in retorts for distilling oil from coal.*

Claims the use of a cylinder retort made of clay, and so arranged as to revolve upon its axis during the process of distillation, or in place of a whole revolution making only three-fourths of a revolution and turning back again, thus producing an oscillating motion for a clay retort.

21,143—August 10, 1858. J. McCUE AND W. B. McCUE. *Improvement in retorts for distilling oils from coal.*

Claims the employment of a connecting pipe located in a retort in other than a central position, whereby we are enabled to conduct off the oleaginous products of the coal while the said retort partially revolves backward and forward on its axis.

23,362—March 29, 1859. JAMES GILLESPIE. *Improvement in revolving retorts for distilling coal oil.*

Claims securing a hopper-like cup in position by means of pins or their equivalents, surrounding the exit journal of each retort, a square-headed shaft passing through a hollow journal at the opposite end of the retort, and an external plate.

23,437—March 29, 1859. JOSEPH E. HOLMES. *Improvement in retorts for distilling coal oil.*

Claims the combination, with an internal vapor pipe, of a leg, so applied as to keep the mouth of the said pipe in the upper part of the retort, either by the direct action upon it of the force of gravitation or by its dragging in the coal or other matter in the lower part of the retort.

24,454—June 21, 1859. HENRY P. GENGEMBRE. *Improvement in retorts for distilling coal oil.*

Claims the use of an L-shaped retort combined with charging boxes, crusher, and discharging tube capable of being subjected to a degree of temperature at the end of the horizontal part, at which the residuum of the substances under treatment is discharged, higher than at the upright part at which the coal is charged, the whole so arranged as to avoid the admission of atmospheric air.

24,587—June 28, 1859. JOHN L. STEWART. *Improvement in retorts for distillation of coal.*

Claims an improved revolving web retort constructed not only with its induction and eduction openings arranged at or near one end of it, but with an endless or other proper carrier made so as to operate to receive the coal or matter to be distilled from or near one end of the retort and carry or force the same toward the opposite end thereof, and from thence backward toward the front end, and there discharge the same, causing the coal or matter to be distilled to pass twice through the retort or carbonizing chamber in such manner, and for securing advantages.

25,103—August 16, 1859. H. P. GENGEMBRE. *Improvement in manufacture of coal oils.*

Claims the continual, progressive, and gradual destructive distillation of coal or other bituminiferous substance for the purpose of obtaining therefrom the different products of distillation.

26,739—January 3, 1860. FRANKLIN W. WILLARD. *Improvement in coal-oil retorts.*

Claims the construction of coal-oil retorts with internal false or extra heads at either end of the retort, and held at proper distance from the heads proper by means of stays or studs, the intervening space between each of the false heads and the end of the retort being filled with clay or other nonconducting material.

27,542—March 20, 1860. H. P. GENGEMBRE. *Improvement in apparatus for distillation of coal.*

Claims a cylindrical or polygonal retort having at the center of both ends a hollow journal or tube, and being susceptible of receiving a continual or occasional movement of rotation or oscillation around its own axis, for the purpose specified.

SUBCLASS 21.—COAL OIL PROCESSES.

12,612—March 27, 1855. ABRAHAM GESNER. *Improvement in processes for making kerosene.*

Claims the process for extracting the liquid hydrocarbons, which I have denominated "kerosene," from asphaltum, bitumen, asphaltic, and bituminous rocks and shales, petroleum, and maltha by subjecting any of these substances to dry distillation, rectifying the distillate by treating it with acid and freshly calcined lime, and then submitting it to redistillation.

15,505—August 12, 1856. L. ATWOOD AND W. ATWOOD. *Improvement in the production of oil from cannel coal.*

Claims an improved oil obtained from natural bodies which alone or when mixed afford paraffine in destructive distillation, and which oil posesses certain described properties.

15,506—August 12, 1856. L. ATWOOD AND W. ATWOOD. *Improvement in preparing oil from bitumens.*

The manufacture and use of lubricating oils from bitumens, such as "Trinidad pitch" and "Barbadoes tar."

21,805—October 19, 1858. L. ATWOOD. *Improvement in extraction of volatile oils, etc., from coal.*

Claims the gradual and progressive formation at a comparatively low temperature of oleaginous vapors and oil from coal or other substances yielding pyrogenic oils by the gradual and progressive action of the heat of products of combustion upon and through the mass operated on.

22,406—December 28, 1858. L. ATWOOD. *Improvement in manufacture of pyrogenic oils.*

Claims forming oleaginous vapors from substances yielding pyrogenic oils by the action of the heat of a properly regulated current of products of combustion passing over and above the surface of the mass operated on, with or without the aid of external heat.

25,598—September 27, 1859; reissue 1,605—January 19, 1864. JOHN HOWARTH. *Improved method of distilling coal, etc.*

Claims distilling coal or other carbonaceous substances for the production of oils, gases, vapors, etc., by passing through the material to be acted upon a current of superheated steam in one body in a vertical plane, or nearly so, through an upright retort; that is, so that a body of superheated steam shall come in contact with every portion of the said material.

62,583—March 5, 1867. S. LLOYD WIEGAND. *Improvement in obtaining oil from paraffine, etc.*

This invention consists in exposing bituminous substances or other matter capable of yielding hydrocarbon oils or paraffine, in a close vessel or chamber, at a temperature below that requisite to decompose the oily or hydrocarbon vapors into permanent gas to the action of the gaseous products resulting from the decomposition of steam by passing it through carbon heated to incandescence, and subsequently extracting the oil and paraffine therefrom, either by pressure or by displacement, by which means I am enabled to separate the oils and paraffine from the crude material at a lower temperature than by any other previously known process, and to obtain both a better quality and better yield of products.

100,915—March 15, 1870; reissue 7,096—May 2, 1876. Division B. RUFUS S. MERRILL. *Improvement in heavy hydrocarbon oils for illumination.*

Claims as an article of manufacture an illuminating oil derived from petroleum, coal, shale, and schist, emitting no inflammable vapor at a temperature of less than 200° Fahrenheit.

100,915—March 15, 1870; reissue 8,728—May 27, 1879. RUFUS S. MERRILL. *Improvement in heavy hydrocarbon oils for illumination.*

Claims a heavy illuminating oil derived from petroleum, coal, shale, or schist, possessing an igniting point of about 300° Fahrenheit and a distilling point of about 600° Fahrenheit.

764,099—July 5, 1904. OTTO P. AMEND. *Process of desulphurizing oil or distillate.*

Claims the process of desulphurizing oil or distillate, which consists in removing the sulphureted hydrogen and neutralizing the fatty and organic acids contained therein; then in exposing the oil or distillate with its sulphur or sulphur compounds to the action of a soluble salt of copper in the presence of an alkali; in removing the excess of copper and copper hydrosulphides and exposing the oil or distillate and any hydrosulphide of copper remaining therein to the oxidizing effect of one or more oxidizing agents; in removing the resulting copper sulphates and settling the oil.

768,101—August 23, 1904. FRANK MACOMB WHITALL. *Process of treating and dissolving wurtzilite.*

Claims the process of treating wurtzilite, which consists in dissolving it in dead oil and then removing the solvent until the mass becomes consistent.

SUBCLASS 22.—COMPOSITIONS.

126,552—May 7, 1872. CHARLES A. JORDERY. *Improvement in solidifying oils.*

The object of this invention is to obviate several inconveniences which are experienced in transporting and handling petroleum, oils of schist, and their volatile essences, as well as oils in general. These products, by reason of their fluidity, are difficult to transport, and spread over all substances or bodies with which they come in contact; and, as regards the petroleum and other volatile oils, develop inflammable vapors, which, besides being dangerous, constitute quite a serious loss.

To remedy these difficulties the inventor solidifies these oils so as to obtain a new industrial product of a greater consistency, and disengaging or giving of less vapor, and capable of being transported and handled with greater facility, by mixing them with a small quantity of decoction of soapwort root.

127,568—June 4, 1872. ROBERT A. CHESEBROUGH. *Improvement in products from petroleum.*

Claims, as a new article of manufacture, vaseline, a thick, oily, pasty substance semisolid in appearance, unobjectionable in odor, becomes fluid at temperature varying from 85° to 110° Fahrenheit, and when fluid is transparent. It will not saponify, does not crystallize, and does not contain paraffine, and in this respect essentially differs from the heavy products of petroleum which have been subjected to destructive distillation and which are known as paraffine oils.

189,401—April 10, 1877. HERBERT W. C. TWEDDLE. *Improvement in petroleum products, and methods of obtaining the same.*

Claims the process for obtaining a new product from petroleum, the same consisting in washing the orange-colored, resinous, oily product obtained toward the close of the distillation of tar residuum, and subsequently driving off the solvent and recovering the heavy oil.

237,484—February 8, 1881. ROBERT A. CHESEBROUGH. *Process of refining vaseline.*

Claims the process of refining vaseline, petroleum oil, and residuum by keeping them just at the point of vaporization in an open vessel until the disagreeable smelling portions are driven off, and afterwards filtering through boneblack.

246,096—August 23, 1881. PETER DITMAR. *Process of solidifying crude and refined petroleum.*

Claims the mode of solidifying liquid hydrocarbons, such as crude or refined petroleum, naphtha residues, and the like, by dissolving 2 to 3 per cent of tallow soap in the hydrocarbon under the action of heat.

454,777—June 23, 1891. JOHN HENRY WILLIAMS STRINGFELLOW. *Process of solidifying liquid hydrocarbons.*

Claims the improvement in the process of gelatinizing or solidifying liquid hydrocarbons, which consists in first mixing with the liquid hydrocarbons a pulverized vegetable saponifier and afterwards adding to and intimately mixing with the first-named mixture a quantity of water.

641,962—January 23, 1900. BERNHARD HOFFMANN. *Process of solidifying petroleum.*

Claims the process of solidifying petroleum oil, which consists in mingling, approximately, ninety-one parts, by weight, of such oil with seven parts of curd soap, and two parts of stearin, heating the mixture until the soap and stearin are melted and thoroughly mixed, and then cooling and solidifying the same.

658,988—October 2, 1900. JOHN A. JUST. *Solidified mineral oil and method of making same.*

Claims a composition of matter, consisting of a mineral oil distillate, thickened or solidified by an aqueous solution of soap, and a substance insoluble in said distillate, and forming with water at ordinary temperatures a tenacious or viscid solution, and,

The process of solidifying mineral oil distillates, which consists in emulsifying such distillates by shaking a quantity thereof with a suitable quantity of a solution of a caseinate and soap in water, and in then gradually adding and incorporating more of such distillates by agitation.

761,939—June 7, 1904. FRIEDRICH BOLEG. *Process of making watery solutions of mineral and rosin oils.*

Claims the process of manufacturing clear and permanent watery solutions of mineral and rosin oils, consisting in treating a mixture of a mineral oil and a crude anhydrous rosin oil with steam, boiling the mixture and adding ly , separating the oil from the soap lye, and then treating said oil with distilled water and compressed air.

SUBCLASS 23.—BURNING FLUID.

1,453—December 31, 1839. ISAIAH JENNINGS. *Improved composition for burning in lamps.*

Claims the use and employment of "oil of whisky" with spirits of turpentine, alcohol, or lamp oil.

7,667—September 24, 1850. EPHRAIM HOWE. *Improvement in burning fluids.*

Claims compounding rosin and the essential oil of vegetables or grain (when the same is produced by distillation of whisky or alcoholic liquors, and thereby become a refuse article) for the purpose of making a material from which to make a gas; also for a burning fluid.

9,119—July 13, 1852. HENRY M. PAINE. *Improvement in benzole lights.*

Claims the mixture of alcohol, benzole, and such proportions of water as shall render the mixture milky in appearance and passing air through the same.

11,229—July 4, 1854. THOMAS DRAYTON. *Improvement in purifying oils.*

Purifies rosin oil and other oils by alcohol.

12,614—April 3, 1855. HENRY W. ADAMS. *Improvement in factitious oils.*

Claims the use of crude turpentine in a mixture made with it and fixed oils.

23,167—March 8, 1859. JONATHAN GRIFFIN. *Improvement in burning fluids.*

Claims a series of mixtures of crude coal naphtha, coal tar, gum turpentine, common wood tar, refined rosin oil, rosin naphtha, and benzol.

23,210—March 8, 1859. WILLIAM WILBER. *Improvement in burning fluids.*

Claims a fluid compound for burning in lamps, etc., made of coal tar, camphene, and alcohol.

25,362—September 6, 1859. N. A. DYAR AND J. F. AUGUSTUS. *Improved compound illuminating fluid.*

Claims a mixture of resin oil, fusel oil, and alcohol.

31,457—February 19, 1861. BENJAMIN F. HEBARD. *Improvement in burning fluid compositions.*

Claims the composition of fusel oil, kerosene, and spirits of turpentine and its combination with a perfuming essential oil.

31,772—March 26, 1861. C. W. PINKHAM. *Improved burning fluid.*

Claims a mixture of refined petroleum, benzole, naphtha or benzoin gum camphor, and essential oil.

35,527—June 10, 1862. SYLVESTER LEWIS. *Improved mode of treating oils and fats for rendering them more useful for burning in lamps, lubricating machinery, and other purposes.*

Claims the treatment of vegetable and animal oils and fats by the use of benzole or naphtha and annotto combined.

38,015—March 24, 1863. CHARLES N. TYLER. *Improved composition for burning fluids.*

Claims the compound produced by the combination of the mineral or earthy oils with fusel oil.

43,166—June 14, 1864. SYLVESTER LEWIS. *Treating oils and fats to form compositions for illuminating and other purposes.*

Claims the treatment of oleine expressed from fats and oils with benzine, benzole, or naphtha.

46,987—March 28, 1865. THOMAS J. BARRON. *Improved mode of preparing inflammable liquids so as to prevent accidents.*

Claims giving to explosive and inflammable oils and fluids used for illuminating and other purposes a bright distinct color to plainly distinguish them from other oils and fluids.

52,574—February 13, 1866. JOHN JANN. *Improved burning fluid.*

Claims the combination of benzine, sweet and linseed oil.

53,709—April 3, 1866. AARON C. VAUGHAN. *Improved burning fluid.*

Claims a burning fluid composed of benzine treated with resin and mixed with ordinary illuminating oil.

54,069—April 17, 1866. WILLIAM CORFIELD. *Improvement in the manufacture of burning fluid.*

Claims causing the alcoholic vapors from a still to pass through spirits of turpentine, or to unite with the vapors of the same.

54,061—April 17, 1866. WILLIAM CORFIELD. *Improvement in the manufacture of burning fluid.*

Claims mixing spirits of turpentine with fermented preparations of grain, or other materials used in the manufacture of alcohol, and distilling the mixture.

54,595—May 8, 1866. HORATIO B. BRACE AND WILLIAM T. SWART. *Improved compound burning fluid for illumination.*

Claims burning fluid for illuminating purposes composed of benzine, naphtha, or gasoline, carbonate of potassa, sulphate of alumina, muriate of soda, gum benzoin, gum camphor, spirits of niter.

55,880—June 26, 1866. DAVID MANSFIELD. *Improved burning fluid.*

Claims a burning fluid for illuminating purposes which is composed of alcohol, naphtha, white oak bark, alkanet root, slippery elm, gum camphor, saltpeter, and rock salt.

57,095—August 14, 1866. JAMES P. CROSS. *Improved burning fluid.*

Claims the combination of gasoline, 70° or 71° gravity; gum olibanum, cascarilla bark lichen.

57,200—August 21, 1866. E. D. SEELY. *Improved burning fluid.*

Claims the compound consisting of naphtha of about 65° gravity, white oak bark, alkanet wood, common salt, and cyanide of potassium.

57,727—September 4, 1866. JOHN JANN. *Improved burning fluid.*

Claims the combination of benzine, sweet oil, and oil of vitriol.

57,749—September 4, 1866. G. H. MELLEN AND J. C. HAZELTON. *Improved burning fluid.*

Claims an illuminating oil composed of naphtha (65°), carbonate of soda, oil of sassafras, alum, gum camphor, ground slippery elm, hydrate of lime, and essence of tar.

58,180—September 18, 1866. JOHN B. SCOTT. *Improved burning fluid.*

Claims the use of naphtha, potatoes, lime, soda, and curcuma.

58,905—October 16, 1866. GEORGE W. SPANGLE. *Improved burning fluid.*

Claims the method for rendering any of the products obtained from petroleum unexplosive and safe as a burning fluid by the use of sal soda and cream of tartar.

60,559—December 18, 1866. WILLIAM B. ROGERS. *Improved burning fluid.*

Claims a burning and carborizing fluid which is composed of crude petroleum, gasoline, benzine, benzole or naphtha, caustic soda, or other suitable alkali, alum, fine salt, and manganese.

63,229—March 26, 1867. HENRY C. DEWITT. *Improved burning oil.*

Claims the mixture formed from and by action of gasoline, powdered alum, cut potatoes, carbon oil, alcohol, gum camphor, oil of sassafras, acetic potash, and sal soda.

63,777—April 9, 1867. ISAAC B. WIGGIN. *Improved burning fluid.*

Claims the incorporation of microcosmic salt with the compound of naphtha, kerosene oil, gum camphor, gum turpentine, oil lemons, and oil cloves, reference being had to the use of denser materials both in the composition of the hydrocarbons and the microcosmic salt, so as to make a fluid that can be burned in any kind of lamp without smoke, bad odor, or danger from explosion.

66,261—July 2, 1867. WILLIAM R. LOOMIS, NELSON WELLS, HARMON HITCHCOCK, AND SAMUEL G. STRYKER. *Improved burning fluid.*

Claims the manufacture of a burning fluid (crystallized oil) made by adding to forty gallons of naphtha, two pounds of alum, two pounds of common salt, one pound potash, and four ounces camphor gum, finely pulverized, and half a pint of spirits of niter.

74,756—February 25, 1868. GEORGE W. FLOWERS, JACOB C. HAPPERSETT, AND DANIEL W. HAPPERSETT. *Improved burning fluid.*

Claims the fluid prepared of gasoline, chloride of sodium, iodine, and quicklime.

75,147—March 3, 1868. DAVID W. FOWLER. *Improved illuminating oil.*

Claims the combination of naphtha, cupri sulphas, zinci oxidum, alumina sulphas et potassium, potassium chloras, camphora, aqua fortis.

82,151—September 15, 1868. JOHN E. NOYES. *Improved illuminating oil.*

Claims the burning fluid composed of coal oil, oil of rhodium, oil of origanum, salts of tartar, Rock Island salt, and common clay, which is then filtered.

98,883—January 18, 1870. JOSEPH PHILIPPS. *Improved mode of producing light by the combination of solid and liquid hydrocarbons.*

Claims the incorporation of one or several of the solid products of the distillation of wood or carboniferous bodies belonging to the coal series into one or several of the liquid products of the same, or their incorporation into naphtha, petroleum, or their distillates, so as to have highly carbureted compounds, and the combustion of these compounds by means of oxygen, for the purpose of producing light.

110,054—December 13, 1870. GEORGE LUPTON. *Improvement in purifying benzine.*

Claims the process for purifying benzine for illuminating purposes by the use of hydrated sesquioxide of iron, hydrate of lime, chloride of barium, carbonate of soda, and paraffine.

146,778—January 27, 1874. ALONZO W. PORTER. *Improvement in the methods of preparing and putting up illuminating oils so as to mark their quality.*

Claims as new articles of manufacture, illuminating oils so colored as to distinguish and mark the different grades or gravities of the safe or nonexplosive oils.

238,867—March 15, 1881. HENRY V. P. DRAPER. *Petroleum illuminating oil.*

The aim and effect of this improvement are to elevate the temperature at which petroleum illuminating oils give off explosive vapors and to raise what is termed the "burning point" of such oils; and the inventor claims—

The herein described compound consists of petroleum, illuminating oil, and chloroform.

250,830—December 13, 1881. WILBER R. MEEDS. *Lantern oil.*

Claims a lantern oil composed of one gallon lard oil, one gallon sperm burning oil, three and three-fourth pounds strained tallow, and one-half pint turpentine.

266,859—October 31, 1882. WILBER R. MEEDS. *Lantern oil.*

Claims in the manufacture of lantern or signal oils the compound consisting in the admixture, with a compound composed of commercial lard oil, commercial illuminating oil—that is, a mixture of lard oil and kerosene—of 300° fire test, and turpentine, in the proportions set forth, of a quantity of refined tallow oil equal in bulk or volume to one-half the volume of the commercial lard oil (irrespective of the lard oil contained in the commercial illuminating oil).

284,811—September 11, 1883. HOWARD R. BURK. *Coloring kerosene oil.*

Claims the method of coloring kerosene, which consists in coloring a substance soluble in or capable of being thoroughly mixed with kerosene, and then dissolving or mixing the said substance or vehicle in the kerosene.

304,390—September 2, 1884. ROBERT A. WILLIAMS AND JOHN BRAGG *Apparatus for coloring oil.*

Claims in a device or apparatus for coloring oil, a funnel having therein a compartment or chamber provided with a foraminous bottom and perforated cover, and oil space formed between the sides of the funnel and the partition of the chamber containing the coloring material.

313,795—March 10, 1885. AUGUST F. ZIMMERLING. *Gas fluid.*

Claims a gas fluid compound of fusel oil, carbon oil, consisting of petroleum distillate at a gravity of about 74° Baumé, and wood naphtha.

340,522—April 20, 1886. JAMES ROOTS. *Process of preparing burning oil for lamps and resulting product.*

Claims the process of improving the illuminating quality of hydrocarbon fluids for burning in the ordinary way in ordinary lamps, consisting in dissolving in such fluids naphthalene in proportion of from, say, 8 to 15 per cent, according to the volatility of the fluid

512,894—January 16, 1894. ALONZO NOTEMAN. *Fuel oil.*

Claims as a new article of manufacture a hydrocarbon oil impregnated with an agent rich in oxygen. The gas employed may be pure oxygen, nitrous oxide, carbon dioxide, etc

557,291—March 31, 1896. ALBERT JOANNES TEMPERE. *Process of deodorizing petroleum and products thereof.*

Claims the process of treating petroleum for the purpose of deodorizing the same, which consists in adding amylacetate thereto.

616,838—December 27, 1898. EMIL GUMPOLDT. *Burning compound and method of compounding same.*

Claims a burning compound produced by the addition of grain soap to a burning fluid heated to or about the boiling point, agitating the emulsion thus formed, and adding shellac and allowing the resulting compound to cool and harden to a substantially solid form, the said ingredients being in the proportions substantially as set forth.

621,338—March 21, 1899. HEINRICH HEMPEL. *Process of producing carbonaceous agents for enriching spirits.*

Claims a process for producing a carbonaceous agent for enriching alcohol, which consists in mixing about five parts by weight of finely powdered naphthalene with about six parts by weight of an aqueous solution of sulphuric acid, gradually heating the mixture to about 160° Centigrade and retaining it at this temperature for about ten hours, allowing the mixture to cool, dissolving the result in water, distilling at 120° to 150° Centigrade, redistilling the products of distillation at a lower temperature, as specified, mixing the result with from two to six parts by weight of a volatile oil rich in carbon of the kind specified and adding the mixture to alcohol.

621,411—March 21, 1899. HEINRICH HEMPEL. *Process of producing luminous spirits.*

Claims a process for producing means for enriching alcohol with carbon, which consists in dissolving one part by weight of a hydrocarbon rich in carbon, such as naphthalene, in from three to six parts by weight of oil of turpentine, agitating the mixture and distilling at the temperature specified, heating the product to boiling point and stirring the same and finally adding to alcohol.

663,010—January 15, 1901 HEINRICH HELBING AND FRANCIS WILLIAM PASSMORE. *Thickening or solidifying mineral oils.*

Claims the method or process of thickening or solidifying a petroleum oil, which consists in treating the same with sodium salt of casein in aqueous solution and then hardening by means of formic aldehyde.

695,128—March 11, 1902. GEORGE EDWARD JAMES STREET. *Illuminating compound.*

Claims an illuminating compound for fairy lamps, bucket lamps, or lamps for ornamental illumination, consisting of a mixture of lard oil, neat's-foot oil, and camphor.

718,818—January 13, 1903. AUGUST H. CRONEMEYER. *Process of solidifying volatile hydrocarbons and alcohol and products thereof.*

Claims a product formed of one part sodium hydrate, one and one-half parts water, five parts alcohol, five parts stearin, two and one-half parts colophony, and fifty parts of an inflammable hydrocarbon.

SUBCLASS 24.—PARAFFIN.

8,888—March 23, 1852. JAMES YOUNG. *Improvements in the treatment of certain bituminous mineral substances and in obtaining products therefrom.*

Claims the obtaining of paraffine oil or an oil containing paraffine and paraffine from bituminous coals by the distillation of the bituminous material and the treatment of the distillates by sulphuric acid and then with caustic soda and the fractioning of the distillate by subsequent distillation.

52,283—January 30, 1866. H. P. GENGEMBRE *Improved process for extracting oils, etc., from minerals.*

Claims extracting oils, paraffines, or bitumens from minerals containing the same by submitting said minerals to the action of light liquid hydrocarbons in a liquid state or in vapor for the purpose of dissolving the oils, paraffine, or bitumen therein contained.

61,946—February 12, 1867. J. B. MERIAM. *Improved apparatus for extracting paraffine, etc., from oil.*

Claims a special form of refrigerator and press by which to express the oil from the mass while chilled.

65,275—May 28, 1867. JOHN E. RICHARDSON. *Improved process of chilling oils and fats.*

Claims the method of chilling oil, so that the ice is brought in direct contact with the lard.

93,739—August 17, 1869. C. CHAUNCEY PARSONS. *Improved process for purifying paraffine.*

Claims melting the paraffine with naphtha and cooling the same while continually agitating it.

102,135—April 19, 1870. FREDERICK LAMBE. *Improvement in treating paraffine and obtaining it in crystals.*

This invention relates to a novel mode of treating and purifying paraffine in the condition of loose crystals, the object being to expedite and economize the operations of separating the crystals from the fluid with which they may be naturally or otherwise associated and of washing and drying the crystals.

To this end the mixture of paraffine and oil is submitted to the action of a centrifugal apparatus acting on the principle of what is known as the hydro-extractor, by which means the solid paraffine is separated from the oil, the paraffine being retained within the apparatus and the liquid or oil passing away through the pervious sides of the same in obedience to the centrifugal law.

102,135—April 19, 1870; reissue 4,397—May 23, 1871. FREDERICK LAMBE. *Improvement in processes and apparatus for purifying paraffine and other substances.*

Claims in combination with a centrifugal extractor the employment of a close cistern or jacket whereby such apparatus is adapted for use in washing and drying crystals of paraffine or other substances or materials which have been treated with hydrocarbon or volatile solvents.

118,359—August 22, 1871. RICHARD GAGGIN. *Improvement in processes for deodorizing hydrocarbon oils.*

Claims pure, dry chlorine gas, either with or without atmospheric air, as a deodorizer of paraffine, kerosene, and other like oils.

129,463—July 16, 1872. SAMUEL H. CROCKER. *Improvement in the purification of paraffine.*

Claims in the process of purifying paraffine, subjecting the paraffine to the action of benzine or other like hydrocarbon at a temperature carried artificially above the melting point of the paraffine (say 80° or 90° Fahrenheit) and continuing them in solution at about the temperature stated till the benzine has taken up all the impurities of which it is capable and then pressing the paraffine in a warm bath.

131,137—September 3, 1872. HEINRICH UIKELY AND CHRISTIAN BEURLE. *Improvement in treating bituminous materials for the manufacture of cerasine or wax.*

Claims a product which is termed "cerasine" and which is obtained by treating ozocerite, asphaltum, mineral pitch, or other equivalent materials.

132,353—October 22, 1872. FRANCIS X. BYERLEY. *Improvement in purifying paraffine.*

Claims the improved process of obtaining or separating paraffine wax from the oil by the action of a pump connected with the receiver in which the paraffine is placed at a point below the perforated false bottom.

132,353—October 22, 1872; reissue 7,559—March 20, 1877. FRANCIS X. BYERLEY. *Improvement in processes of purifying paraffine wax.*

Claims the process of separating paraffine wax from the oil, which consists in removing the latter from a chilled mass of the paraffinized material by a continuous direct exhaust or suction action.

133,042—November 12, 1872. ROBERT M. LETCHFORD AND WILLIAM B. NATION. *Improvement in the treatment and purification of paraffine.*

Claims the treatment of paraffine with water in such manner as to wash out or remove the softer, more fusible, and impure parts, leaving the harder and purer paraffine in its original solid form.

164,672—June 22, 1875. FRANCIS X. BYERLEY. *Improvement in apparatus for purifying paraffine, etc.*

Claims the method of purifying and crystallizing paraffine and the like, consisting in crystallizing the substance in closed cylinders by heat or cold and straining off the waste, then purifying such crystallized substance in a receiver having a filter bottom, with the proper solvents.

177,347—May 16, 1876. JOSEPH B. MERIAM. *Improvement in separating paraffine from hydrocarbon oils.*

Claims the process of separating paraffine from hydrocarbon oils, the same consisting in first placing a mass of paraffine scales on a rigid screen secured within a proper receptacle and then forcing chilled hydrocarbon oil through said mass, the strata of paraffine scales that accumulates on said mass being removed from time to time.

181,814—September 5, 1876. FRANK Q. BARSTOW. *Improvement in apparatus for purifying paraffine.*

Claims in an apparatus for purifying paraffine wax or other analogous substances, the combination of a closed receptacle or vessel having a perforated bottom for supporting the substance to be operated upon, with a pipe for admitting the purifying element and pipe for the admission of compressed air to the chamber above the perforated bottom.

186,951—February 6, 1877. CARL MARIA PIELSTICKER. *Improvement in processes for refining crude ozocerite.*

Claims the process of refining crude ozocerite by melting in an agitator, then adding sulphuric acid, agitating, and, when a drawn sample, freed from impurities, presents a yellow color, drawing off the impurities and washing the ozocerite repeatedly with hot water, allowing it again to settle, and then agitating with carbonate of baryta and caustic soda; when sufficiently agitated drawing off the spent chemicals and adding to the ozocerite a saponifiable oil or fat, rosin, turpentine, or soap, and caustic soda, agitating, allowing to settle, drawing off impurities, washing repeatedly in hot water, allowing to rest, and, when the ozocerite is of a light yellow color, filtering it through animal charcoal, so as to obtain a whitish wax-like material suitable for similar purposes for which beeswax, paraffin, and stearin are now in use.

211,762—January 28, 1879. THOMAS MARRIN. *Improvement in purification of paraffine oils.*

Claims in the art of obtaining paraffine wax, clarifying the paraffine oil before congelation with sludge acid, by mixing and agitating the two, decanting the paraffine, washing it with warm water, and neutralizing any residuary acid with alkali.

215,471—May 20, 1879. FRANCIS MARION McMILLAN. *Improvement in processes for freezing and pressing paraffine oil.*

Claims the process of separating lubricating oil and refined paraffine contained in the product of crude paraffine distillate of petroleum in one continued process, by subjecting said product to a freezing temperature, and while in this state applying a sufficient degree of pressure, by means of condensed air forced into the chamber containing the material, to force the oil from the paraffine through a filtering diaphragm.

228,549—January 13, 1880. WILLIAM M. SLOANE AND ROBERT M. POTTER. *Process and apparatus for manufacturing paraffine wax.*

Claims the process of purifying, cleaning, and refining paraffine wax and other wax or fatty matters, consisting in introducing the wax or fatty matter and naphtha into a cylinder, heating the same by means which do not allow the contact of the heating agent with the wax or fatty matter and naphtha, agitating the said wax or fatty matter and naphtha until thoroughly combined, then passing the compound into a filter without allowing it to cool, keeping it heated as it passes through the filter, and subsequently separating the wax or fatty matter from the remainder of the compound.

235,057—November 30, 1880. WILLIAM M. SLOANE AND WILLIAM BELL. *Process of refining paraffine wax.*

Claims the process of purifying, cleaning, and refining paraffine wax, other waxes, fatty matters, rosins, and gums, consisting in forming a solution thereof, with naphtha or other solvent, through heat and agitation, subsequently cooling and congealing the same, next subjecting the same to pressure and then filtering, keeping the mass heated during the filtering.

242,554—June 7, 1881. HERMAN NEAHOUS. *Press for treating paraffine oils.*

Claims in a press for treating paraffine oils, an oil receptacle or press box having suitable discharge pipes, in combination with a stationary wax filter attached to and forming part of one of the heads of the press, and a movable wax filter attached to and forming part of the press plunger.

244,431—July 19, 1881. FRANCIS X. BYERLEY. *Apparatus for and process of treating paraffine.*

Claims the improved process of treating paraffine by one continuous operation, consisting in reducing the paraffinized oil to a frigid mass in a receiver, and then discharging it into a percolator, and while therein and in motion subjecting the mass in detail to the action of a solvent for the separation of the oil from the paraffine during its passage through the said percolator, assisted in its separation by the action of a pump or vacuum for drawing off the free oil and solvent.

248,735—October 25, 1881. DANIEL T. GRAY. *Process of and apparatus for purifying wax, fats, or resins.*

Claims the improvement in the process of purifying wax or equivalent material, consisting in causing a stream of wax, while in a fluid or melted state, and a stream of naphtha or other solvent to flow together, and thus form an intimate mixture or solution, and thence pass through a filter.

250,524—December 6, 1881. DANIEL T. GRAY. *Process of and machinery for refining and purifying paraffine and other waxy materials.*

Claims the process for purifying and refining paraffine and other waxy matters, consisting, essentially, in subjecting the crude wax to a solvent and heated air, under pressure, in a closed vessel, passing the mixture through a filter provided with a heating jacket, to remove the earthy matters, then freezing the wax in a closed chamber, then compressing it to remove the solvent, and then again melting it by steam or hot air to drive off all traces of the solvent.

266,929—October 31, 1882. HENRY WARDEN. *Filtering petroleum distillates for the separation of paraffine.*

Claims the process of first cooling petroleum distillate and then maintaining it in a cooled condition while it is being press filtered.

267,752—November 21, 1882. SOLOMON W. KIRK. *Separating wax from paraffine oil.*

Claims the improvement in the art of separating wax from paraffine oil, which consists in the addition of paraffine wax to the crude paraffine distillate of petroleum.

281,491—July 17, 1883. DANIEL T. GRAY. *Filtering apparatus for purifying paraffine, etc.*

Claims the combination, with one or more filter boxes constructed to admit air at the top, and a receiving tank for the filtrate, of a pipe, or passage for the removal of air and vapor from the tank, and an educting steam jet connected with said pipe or passage and discharging outwardly therein, whereby a partial vacuum may be maintained in the receiving tank.

284,437—September 4, 1883. EDWARD D. KENDALL. *Process of and apparatus for preparing petroleum jelly.*

Claims the method of producing a substance from petroleum residues resembling somewhat the material known as "petroleum jelly," and which process consists of the following steps: First, heating the said residues to nearly the boiling point of alcohol, or to a temperature of about 170 degrees, if the alcohol has a specific gravity of 0.816, and simultaneously heating a larger volume of alcohol to substantially the same temperature; second, thoroughly commingling the said heated residues and alcohol by mechanical agitation; third, subjecting the substances thus combined to the action of gravity and differences of temperature for the purpose of separating the insoluble elements from the hot alcoholic solution; and, fourth, drawing off the alcoholic solution into a settling and cooling tank, where, during the operation of cooling, the alcohol rises to the surface and is drawn off, to be returned to the original circulation, while the jelly is left in the cooling and settling tanks.

297,766—April 29, 1884. JEAN CHARLES OCTAVE CHEMIN. *Process of preparing ozocerite and other solid hydrocarbons.*

Claims the method of treating or preparing ozocerite and other similar hydrocarbons, which consists in first removing the earthy insoluble impurities by the means substantially as described, then heating the thus purified substance in a retort in connection with sulphur in about the proportion specified, and submitting the same to the action of superheated steam in the retort until it distills over.

306,653—October 14, 1884. ROLLIN H. SMITH. *Process of extracting paraffine from oils by filter press.*

Claims extracting paraffine or solid substances from oils or other liquids by a series of filter plates so arranged in a frame that the flexible rims of such plates, coming together, form a tight joint and an inner receptacle between the web of the plates for the deposit of the solid substances.

347,288—August 10, 1886. FRANCIS X. BYERLEY. *Purifying paraffine and extracting oil from oleaginous materials.*

Claims the method of treating materials containing bodies of different fusibility by forcing through the same gas or vapor heated to or above the melting or liquefying point of the softer portions, and below that of the harder portions, and withdrawing the liquefied from the solid portions.

369,902—September 13, 1887. GEORGE AAB AND SANFORD K. CAMPBELL. *Method of extracting paraffine or other bodies from petroleum.*

Claims the method of extracting paraffine or other bodies from petroleum, which consists in forcing the petroleum through a cloth previously coated or impregnated with paraffine, whereby the paraffine or other solids contained within the oil will be separated therefrom.

387,357—August 7, 1888. MOSES S. HIGBIE AND ALBERT W. DOUGHERTY. *Asphaltum compound and process of making the same.*

Claims the process of refining asphaltum, which consists in adding it in small quantities from time to time to a bath of melted paraffine wax and mineral oil and subjecting it to heat sufficient to melt it and to volatilize certain impurities therein contained.

387,358—August 7, 1888. MOSES S. HIGBIE AND ALBERT W. DOUGHERTY. *Bitumen compound and process of making the same.*

Claims the process of hardening bitumen, consisting in melting it with paraffine wax and subjecting the same to heat to remove the volatile impurities.

400,042—March 26, 1889. JOHN E. BICKNELL. *Process of purifying paraffine wax.*

Claims a process for purifying or refining a substance having portions of different fusibility, the same consisting in forcing up through the substance a fluid heated to or above the liquefying point of the softer portions of the substance, simultaneously disintegrating said substance, then gradually withdrawing a portion of the upper portion of said fluid, simultaneously floating off a portion of the substance treated liquefied at said temperature, and gradually introducing beneath the substance the fluid withdrawn and forcing it again through the substance treated, thus causing said fluid to have a constant circulation through the substance treated.

400,043—March 26, 1889. JOHN E. BICKNELL. *Process of purifying paraffine wax.*

Claims a process of purifying or refining a substance—such as paraffine or other like substance containing portions respectively of different points of fusibility—the same consisting in reducing the substance to a finely divided condition and then passing through said substance a fluid having a temperature substantially equal to or above the liquefying point of the softer portion of said substance and below the liquefying point of the harder portion of said substance, and removing the liquefied portion from the solid portion of said substance.

490,199—January 17, 1893. NORMAN MACFARLANE HENDERSON. *Treating or purifying paraffine wax and apparatus therefor.*

Claims in an apparatus for treating or purifying paraffine wax, the combination of a chamber having longitudinal and transverse heating pipes, metal trays carried by the transverse pipes, strainers consisting of frames carrying longitudinal and transverse wires and fine wire gauze on the wires supported at a small height above the bottom of the trays, the said trays provided with outlets below the said strainers, and overflow ducts from one tray to the next lower one, with swiveling nozzles communicating with the said outlets, gearing for simultaneously turning each set of nozzles and hoppers into which the nozzles discharge.

558,358—April 14, 1896. WILLIAM P. COWAN. *Apparatus for treating paraffine wax, etc.*

Claims the method of treating a mass of material of the nature described, to subject it progressively to different temperatures for the purpose set forth, which consists in pouring the mass in a melted condition into a receptacle provided with numerous fluid current conveying tubes, which are thereby embedded in the mass, passing through the tubes a cooling fluid and thus producing an approximate solidification of the mass, then passing through the tubes heating fluid currents of progressively higher temperature, and withdrawing from the mass and collecting the material as it melts.

653,235—July 10, 1900. ALANSON McD. GRAY. *Apparatus for molding wax.*

Claims a flat open-sided mold permanently closed at its bottom and ends and having an opening at the top for the introduction of the material, in combination with independent removable hollow chilling plates forming the closing sides thereof, a support upon which the mold and plates are mounted and upon which they are independently movable laterally or flatwise, and means, for circulating a cooling medium through the plates, whereby the mold and plates may be pressed together, thus closing the mold at its sides and separated after the material in the mold is chilled or solidified to permit the removal of the cake laterally from the mold.

689,381—December 24, 1901. EDGAR VON BOYEN. *Process of manufacturing mineral wax.*

Claims a process for producing, from bituminous brown coal, a wax-like substance, consisting of an acid and an unsaturated hydrocarbon, according to which an extract is first obtained from the coal by means of suitable solvents such as benzoin, benzene, and the like, which extract is converted into the mineral wax by distillation with superheated steam, under rarefaction.

690,693—January 7, 1902. EDGAR VON BOYEN. *Process of manufacturing mineral wax from bituminous brown coal.*

Claims the process for producing mineral wax, which consists in distilling bituminous brown coal, in a dry condition in the presence of superheated steam and then distilling the extract thus obtained, in presence of superheated steam and under rarefaction.

781,854—February 7, 1905. RICHARD THOMAS. *Cooler.*

Claims a cooler comprising, in combination, a series of closed cooling compartments the top and bottom of which are composed of cooling plates, an injector operating in each compartment between said cooling plates and passages whereby said compartments are connected through said cooling plates, the passage in each plate being at a different angle from the passage in the other plates to form a progressive series of passages around the center of the cooler, said cooling plates being hollow and provided with connections for the circulation of a cooling fluid through the series.

SUBCLASS 25.—PROCESSES.

36,632—October 7, 1862. A. H. PERKINS. *Improved process of treating coal tar to manufacture roofing cement.*

This process consists in igniting the bulk of coal tar itself about its surface, and at the same time subjecting it to an agitation, thus feeding the flame and consuming and evaporating the portions necessary to be disposed of before the proper consistency can be attained.

135,879—February 18, 1873. PETER BARTHEL. *Improvement in treating asphalt.*

Claims the arrangement of a sieve in a kettle above the material to be dissolved.

159,655—February 9, 1875. HENRY H. EDGERTON. *Improvement in processes of treating hydrocarbons for making gas.*

Claims for use in the process of manufacturing illuminating gas from gas producing hydrocarbons by presenting hydrocarbons of the same constitution in the retort at the same time, the method of preparing said hydrocarbons, by separating the same into liquid subdivisions whose respective constituents have substantially identical decomposing points, as set forth, whereby any one of said subdivisions is available in liquid form for gas making purposes, independently of the others.

162,394—April 20, 1875. ARCHIBALD K. LEE. *Improvement in processes of reducing asphaltum to a liquid.*

Claims the process of reducing asphaltum to a liquid, and holding the same in a fluid condition without heat or the use of dead oils, but through the action alone of a product obtained by the redistillation of the spirits of turpentine, and in then separating from the same the water, acids, and all resinous substances, and in then concentrating and rectifying the same.

162,394—April 20, 1875; reissue 8,921—October 7, 1879. ARCHIBALD K. LEE. *Improvement in processes of reducing asphaltum to a liquid.*

Claims as a new article of commerce, fluid asphaltum, the same having been reduced to a liquid through the action of a solvent and without heat, for paving, roofing, and other purposes.

178,889—June 20, 1876. JOHN J. THOMAS. *Improvement in apparatus for separating ammoniacal liquor from gas tar.*

Claims the combination, in an apparatus for separating commingled liquids having different specific gravities, of a tank or chest, an inlet pipe, a series of vertical dividing plates, a lower transverse dam, and upper and lower delivery pipes.

236,996—January 25, 1881. EDWARD J. DE SMEDT. *Bituminous cement.*

Claims the improvement in the art of preparing coal tar products for use in bituminous cements or compositions for paving and other purposes, which consists in subjecting said products, while maintained in a heated condition, to the action of an oxidizing agent.

237,662—February 8, 1881. EDWARD J. DE SMEDT. *Bituminous cement.*

Claims the improvement in the art of preparing heavy petroleum oil for use in bituminous cements and compositions for paving and other purposes which consists in subjecting said products, while in heated condition, to the action of an oxidizing agent.

239,260—March 22, 1881. JULIUS I. LIVINGSTON. *Plastics from petroleum.*

Claims the process of making petroleum asphaltum by eliminating from the heavy residual product the coke or coke producing elements by precipitation, followed by distilling.

248,074—October 11, 1881. CYRUS M. WARREN. *Roofing, paving, and varnish material.*

Claims as a new manufacture, the bituminous residuum obtained by exposing wax tailings to a distilling process.

258,778—May 30, 1882. JAMES LIVESEY AND JAMES KIDD. *Mode of manufacturing naphthalene into a form for carbureting.*

Claims the process of obtaining refined naphthalene, consisting in first heating the crude naphthalene in a closed boiler, then passing a current of air over its surface for collecting the naphthalene, then conducting the air impregnated with the naphthalene into a condensing chamber, where the naphthalene is freed from the air, then reheating the collected naphthalene, and finally molding the same in refrigerated molds.

376,289—January 10, 1888. HEINRICH BUSSE. *Process of making artificial or elastic bitumen for paving.*

Claims the process of manufacturing artificial elaterite from naphtha or liquid bitumens, consisting in subjecting the materials to a proper degree of heat, cooling and mixing them with vegetable oils, fatty or sebacic acids, treating the mixture with nitrous acid and compressed atmospheric air, and subjecting the entire mixture to a proper degree of heat.

387,357—August 7, 1888. MOSES S. HIGBIE AND ALBERT W. DOUGHERTY. *Asphaltum compound and process of making the same.*

Claims the process of refining asphaltum, which consists in adding it in small quantities from time to time to a bath of melted paraffine wax and mineral oil and subjecting it to heat sufficient to melt it and to volatilize certain impurities therein contained.

399,073—March 5, 1889. GEORGE H. PERKINS. *Process of distilling petroleum.*

Claims the process of distilling a petroleum product and separating its distillates, which consists, in treating said product with heat in a still, in passing the resulting vapors through a suitable condenser, in conveying by suitable conduits, the lighter distillates to a proper receiving vessel, and in conveying the heavier distillates, which have not been trapped back into the original still, to a supplementary vessel or still in which they may, without other heat than that originally derived from the original still, further separate into heavier and lighter products.

481,391—August 23, 1892. JACOB P. ENGLE. *Recovering waste products of petroleum.*

Claims the process of separating waste petroleum products in which the water globules are covered with petroleum oil, consisting in mixing and agitating with such combined products a dry material which breaks up the globules by absorbing the lighter oil and spirit, then discharging the heavy oil or residue and water into a tank to enable the said heavy oil or residue to settle, and finally separating the water from the heavy oil or residue.

488,767—December 27, 1892. JOHN LAING. *Destructive distillation of mineral oils.*

Claims an improved process for treating heavy mineral oils to obtain lighter oils, the said process consisting in distilling the oil from a series of compartments or vessels, the liquid in all of which is in communication, and passing the volatilized matters through condensers from each compartment or vessel to the next in order and from the last to ordinary condensers, the condensed products from each condenser but the last being led to the body of oil under treatment in the successive compartments.

500,252—June 27, 1893. HERMAN FRASCH. *Composition for purifying Canadian or similar petroleum and process of making such composition.*

Claims the new composition for removing sulphur compounds from Canadian and similar "skunk" bearing oil, consisting of one or more metallic oxides soluble in such oil (as the oxides of lead and copper) in a finely divided form on or in particles of a comminuted refractory carrier or vehicle, said composition being characterized by practical homogeneity, in consequence of the presence together of the said metallic oxide and the said carrier or vehicle in the individual fine grains or granules of the composition, and also by the velvety fineness and permeability of the said metallic oxide.

505,416—September 19, 1893. ARTHUR F. L. BELL. *Process of extracting and refining asphaltum, etc.*

Claims the improvement in the process of extracting and refining asphaltum, mineral pitch, bitumen, Trinidad lake pitch, petroleum, petroleum oils, paraffine, paraffine oils, and kindred substances, which consists, first, in heating in water and keeping in motion the material with its carrying sand, or vehicle, whereby the former separates from the sand, or vehicles, and rises and floats on the surface of the water, and then in discharging the carrying sand, or vehicle, and subjecting the material to be refined to centrifugal force, whereby it is separated from the water with which it became impregnated in the process of separation from the sand, or vehicle.

512,548—January 9, 1894. WALTER S. WILKINSON. *Process of refining asphalt.*

Claims the process of refining natural asphalt, which consists in subjecting it in an open tank or vessel, in its crude state and under agitation, to the action of steam heat disseminated throughout it.

512,494—January 9, 1894. RICHARD D. UPHAM. *Process of refining asphalt.*

Claims the process of refining natural asphalt, which consists in subjecting it in an open tank or vessel, in its crude state, and while under subjection to the action either of steam or of fire heat, to the heating and agitating influence of steam disseminated throughout it by direct injection.

549,399—November 5, 1895. HARVEY LEE SELLERS AND HUGH RONALD. *Method of and apparatus for treating mineral pitch.*

Claims the method for treating mineral pitch, consisting in subjecting the material to the action of heat while submerged in hot water, to disintegrate the material, to separate the asphalt and asphalt oil from the impurities, and to permit the asphalt and oil to rise in the water to the surface thereof, discharging the sand and other impurities by gravity, connecting the sand discharge or outlet with a body of water, and maintaining a current through said body of water, whereby the sand and débris falling therein may be continuously discharged.

551,294—December 10, 1895. CLIFFORD RICHARDSON. *Process of dehydrating crude asphalt.*

Claims the process of dehydrating crude asphalt, which consists in successively and alternately grinding or pulverizing the same and drying it in order to reduce it from its natural state of emulsion to a dry powder.

580,592—April 13, 1897. ARTHUR F. L. BELL. *Apparatus for refining asphaltum.*

Claims in an apparatus for refining asphaltum, a rotatable closed drum for receiving the charge of material, means for admitting air or steam to the interior of the drum, and means for permitting the escape of the gases therefrom, consisting of the hollow axle of the drum provided with openings into the drum and a conical shield surrounding the axle and protecting said openings.

581,451—April 27, 1897. ARTHUR F. L. BELL. *Apparatus for refining asphaltum.*

Claims in an apparatus for refining asphaltum the combination of a stationary casing or shell and an interior revoluble drum or cylinder having end openings and separated from said shell to form a circumscribing space, with which it communicates, said drum or cylinder having its inner face provided with means rigid therewith for advancing the material, means for supplying the material to said drum, means for effecting the flow of a solvent through the drum in opposition to the path of movement of the material therein, and means whereby the vaporized solvent may be recovered.

581,546—April 27, 1897. HANS A. FRASCH. *Method of and apparatus for refining asphalt.*

Claims the method of extracting bitumen from bituminous rock, which consists in exposing the rock in a series of closed and heated vessels to the action of a solvent, at a temperature less than the boiling point of bitumen and at or above the boiling point of the solvent, flowing the solution through the series of rock filled vessels from one end of the series to the other, condensing the vaporized solvent and returning it to either of the vessels, whereby a continuous circulation of the solvent is produced simultaneously with the onflow of the solution, and the solution finally concentrated in the last of the series of vessels.

597,892—January 25, 1898. WALTER S. WILKINSON. *Process of treating asphalt.*

Claims the process of desalifying and removing nonbituminous organic matter from asphalt, which consists, first, in comminuting it, and, second, in agitating the comminuted product in water.

611,620—October 4, 1898. CHAUNCEY B. FORWARD AND JOHN M. DAVIDSON. *Method of obtaining asphalt from crude petroleum and petroleum tar.*

Claims the process of making asphalt from crude petroleum by treating the crude petroleum with acid to separate the carbonaceous matter from the oils, washing the carbonaceous matter to free it from the acid, then mixing it with heavy hydrocarbon oil and subjecting it to a high degree of heat for a considerable period.

617,226—January 3, 1899. AUGUSTUS STEIGER COOPER. *Method of and apparatus for extracting bitumen from sand.*

Claims the method for separating bitumen from sand, consisting in subjecting the material to the action of crude petroleum oil to soften and dissolve the bitumen contained in the sand, and then subjecting the mass to the action of a benzine solvent for the bitumen, mechanically agitating the mass, separating the solution from the sand, evaporating the solvent from the asphalt, and returning the solvent in vaporized form to fresh portions of the oiled sands.

617,712—January 17, 1899. ARTHUR F. L. BELL. *Machine and apparatus for extracting and refining asphalt.*

Claims in an asphaltum extracting and refining apparatus, revoluble mixing vessel or cylinder provided on its interior with a helical vane to move the material longitudinally, longitudinal vanes set between the convolutions of the helical vane to raise and agitate the asphaltic material, a sealed steam-jacketed feedway to introduce the asphaltic material and means for introducing a liquid solvent to be incorporated therewith.

620,082—February 21, 1899. CHARLES E. ANTHONY. *Wurtzilite product and apparatus.*

Claims a soluble and fusible wurtzilite product possessing the characteristics of the crude material in form, elasticity, hardness, color, and electric properties.

629,059—July 18, 1899. FREELING W. ARVINE. *Method of separating emulsions.*

Claims the method of treating water-gas tar, which consists in adding a coagulent, filtering under pressure, and then heating.

630,496—August 8, 1899. HERMAN FRASCH. *Cleansing purifying agent employed in purifying petroleum.*

Claims as a step in the process of removing the sulphur compounds known as "skunk" from skunk bearing petroleums, by the subjection of such oil or its vapors of distillation in a heated vessel to a metallic purifying agent or purificator in a fragmentary condition, whereby the particles of such metallic purificator become surface coated with its sulphide, the removal or separation of such sulphide coating from the purificator when so coated, by subjecting it to the action of a solvent, either of the sulphide or of the metallic substance coated therewith, whereby the sulphide coating is loosened and detached from its surface, either by being itself dissolved in the solvent or separated by the action of the solvent on the surface of the purificator.

635,429—October 24, 1899. GEORGE F. CULMER AND GEORGE C. K. CULMER. *Process of making asphaltic fluxes.*

Claims the method of preparing asphaltic fluxes, which consists in dehydrating petroleum residuum, holding the mass in heated state sufficient to drive off water but below the pitch forming temperature, e. g., below 550° Fahrenheit, and simultaneously blasting the charge with air so as to profoundly modify the characteristics thereof, thus markedly lessening the petrolene content and markedly increasing the asphaltene content without material loss through destructive distillation, while the volume and specific gravity of the finished batch remain essentially the same as in the dehydrated residuum.

635,430—October 24, 1899. GEORGE F. CULMER AND GEORGE C. K. CULMER. *Asphaltic flux.*

Claims a black, semisolid asphaltic flux devoid of pitch, the same consisting of dehydrated and oxidized petroleum residuum nearly alike in volume and specific gravity, with the original residuum but markedly higher in its content of asphaltene and lower in its petrolene than the residuum from which it was derived and possessing the characteristics of a product obtained by prolonged exposure of petroleum residuum to a heat below pitch forming temperature, e. g., below 550° Fahrenheit, under copious injection of air to transform the mass without material distillation.

646,639—April 3, 1900. JESSE A. DUBBS. *Distilling petroleum.*

Claims as an improvement in the art of vaporizing oil the method which consists in producing an initial vaporization of the oil by heating the same, then forcing air through the oil in such regulated quantities that the volume of air thus introduced will not at any time be greater than four times the volume of vapor given off by the oil and maintaining the oil at a vaporizing temperature during the introduction of air.

654,258—July 24, 1900. JOHN P. HART. *Process of separating water from emulsions, etc.*

Claims the process of separating water from mixtures, emulsions, and compounds of oil or tar and water consisting in gradually passing the mixture, emulsion, or compound to be treated into a mass of the dehydrated oil or tar previously heated to a degree of heat in excess of that which would cause the separation of water, as steam from a mass of hydrated oil or tar, whereby the water is driven off from the inflowing stream of hydrated oil or tar immediately on its becoming mixed with the heated dehydrated material.

655,430—August 7, 1900. ARTHUR F. L. BELL. *Apparatus for extracting and refining asphaltic material.*

Claims in an asphaltum extracting and refining apparatus, a stationary casing, a revoluble main cylinder therein, with means for heating the exterior of said cylinder, a central concentric hollow core or drum fixed within said cylinder and revolving therewith, with means for heating said drum, and means for introducing and removing the material to be treated within the annular chamber included between said cylinder and drum.

659,076—October 2, 1900. FREDERIC LENNARD. *Process of separating free carbon from tar.*

Claims the process of distilling tar to separate the free carbon therefrom, consisting in diluting the tar with an oil or spirit, which will, in combination with the said tar, produce a mixture having an appreciably lower vaporizing point than the tar alone has, and subjecting the mixture to the action of heat and of steam, and thereby effecting simultaneously the volatilization of the liquid portion and the deposit of the free carbon.

671,078—April 2, 1901. JOHN T. DAVIS. *Distillation of petroleum.*

Claims the process of producing a residuum suitable for use as a binder for artificial fuel, which consists in distilling crude petroleum in the presence of an oxidizing agent, and to a temperature approximating to but below 660° Fahrenheit, and continuing the distillation at such temperature until the residuum has reached the condition desired.

688,073—December 3, 1901. ALLAN WADE DOW. *Manufacture of asphaltic cement.*

Claims the herein described artificial paving asphalt, consisting of the product obtained from oils having asphaltic bases by prolonged distillation thereof at temperatures sufficiently high to produce severe cracking, said product being substantially insoluble in petroleum naphtha, combined with a suitable flux.

722,500—March 10, 1903. JAMES S. DOWNARD AND BYRON A. ROLSON. *Apparatus for treating rock asphalt.*

Claims an apparatus for treating rock asphalt, comprising a separator having a tank, a feed trough with orifices therein, means for feeding material to the trough, and slide plates adjustably mounted on the feed trough to control the orifices thereof.

734,483—July 21, 1903. SAMUEL RUCKER WHITALL. *Process of treating wurtzilite for paints, varnishes, etc.*

Claims the process of dissolving wurtzilite by subjecting it to the solvent action of petroleum or its distillates.

755,809—March 22, 1904. ALEXANDER NIKIFOROFF. *Manufacture of the benzols and their homologues.*

Claims the process of treating raw materials, substantially as set forth, for the production of an aromatic distillate capable of yielding benzol, which consists in decomposing the raw material under the effect of heat, in condensing the volatile distillate having a boiling point of 200° centigrade or under, and in subjecting such distillate to the effect of a temperature of about 750° centigrade under a pressure above that of the atmosphere, in collecting the distillate of the second decomposition whose boiling point is approximately 200° centigrade or over, and in separately collecting the aromatic distillate of the second decomposition whose boiling point is 200° centigrade or under.

768,796—August 30, 1904. LOUIS GATHMANN. *Process of distilling or refining hydrocarbon oils and spirits.*

Claims the process of distilling or refining hydrocarbon oils or spirits, which consists in causing a circulation of a gaseous fluid under diminished atmospheric pressure through said liquid to be distilled or refined, causing a fractional condensation of the distilled or refined product and returning said gaseous fluid through said liquid under treatment.

781,240—January 31, 1905. ERIC A. STARKE. *Method of rendering asphaltic oils more liquid.*

Claims the process of rendering heavy mineral oils more liquid, which consists in subjecting the oil to a partial distillation at a temperature ranging from 500° to 650° Fahrenheit and reuniting the distillate and residuum and mixing the mass thoroughly.

805,116—November 21, 1905. Serial No. 170,233, August 20, 1903. GEORGE H. BRADFORD. *Process of distillation.*

Claims the vacuum process of distilling, which consists in drawing the vapors of distillation to a height greater than the height to which the liquid being distilled can rise in a vacuum, and then delivering such vapors to a condenser.

807,983—December 19, 1905. JAMES PHILIP WINTZ. *Process for treating petroleum oils.*

The invention consists also in cleaning and purifying the asphaltum by washing it in an alkaline solution, and the inventor—

Claims a step in the process which consists in separating asphaltum from crude petroleum oil by means of gasolene and sulphuric acid, treating the separated asphaltum with gasolene, water, and caustic soda, and then passing the asphaltum so treated through an evaporator.

SUBCLASS 26.—CHEMICAL.

11,203—June 27, 1854. ABRAHAM GESNER. *Improvement in kerosene burning fluids.*

Claims the distillate having a boiling point of 150° F. and specific gravity 0.750, obtained from petroleum, maltha, bitumen, and the like by dry distillation, treatment with sulphuric acid and lime, and subsequent distillation.

11,204—June 27, 1854. ABRAHAM GESNER. *Kerosene.*

Claims as a new composition of matter the fraction obtained in the distillation of petroleum, maltha, or soft mineral pitch, asphaltum, or bitumen, by dry distillation and subsequent treatment with powerful reagents or redistillation, which has a specific gravity of 0.8 and a boiling point of 350° F.

11,205—June 27, 1854. ABRAHAM GESNER. *Improvement in kerosene burning fluids.*

Claims the distillate having a boiling point of 250° F. and specific gravity 0.775 obtained from petroleum, maltha, bitumen, and the like by dry distillation, treatment with sulphuric acid and lime, and subsequent distillation.

13,358—July 31, 1855. S. MEREDITH. *Improvement in the distillation of cannel or other bituminous coals.*

Claims the production of naphtha, benzole, and other hydrocarbon liquids by the distillation of cannel or other bituminous coal in an atmosphere of heated hydrogen gas or in a retort to which a stream of heated hydrogen gas is admitted during the distilling process.

22,727—January 25, 1859. E. N. HORNER. *Improvement for process of extracting oil from coal, shale, and other minerals.*

Claims the use of a mixture of cream of tartar, common salt, and slaked lime for the purpose of condensing the oleaginous vapor produced by the dry distillation of coal, shale, or other bituminous minerals, extracting the oil from the gas and depriving the gas of its inflammable quality, and throwing off the sulphurous vapor.

31,982—April 9, 1861. JAMES J. JOHNSTON. *Improvement in the distillation of hydrocarbon oils.*

Claims the process and method of purifying, decolorizing, and deodorizing rock or petroleum oil by distilling it with common wood charcoal.

36,419—September 9, 1862. ANTONIO MEUCCI. *Improvement in treating petroleum and other oils to produce a vehicle for paints and varnishes.*

Claims the employment or use of hyponitric acid in treating petroleum, kerosene, or other oils, and the mixing petroleum or other oils after they have been exposed to a current of hyponitric acid with linseed or with linseed cakes and fish oil.

40,068—September 22 1863. R. N. WARFIELD. *Improvement in deodorizing petroleum, naphtha, etc.*

States that "The process of deodorization now in general use is to introduce *10 per cent of sulphuric acid into the* distilled oil and agitate the mass. When settled, the acid is drawn off. The result is to only change the odor, not to reduce the volatility, and to destroy an equal amount of oil to that of the acid introduced. To destroy the floating particles of acid, a strong solution of caustic soda is introduced, which neutralizes the acid and changes a portion of the oil to soap, and is passed off at the additional expense of the destruction of a portion of the oil."

And he claims in lieu of this, deodorizing petroleum, naphtha, etc., by the introduction of a volume of steam into the liquid beneath its surface in such a manner that the steam is distributed throughout the contents, and removes the gas by its passage through the oil, and passing the steam through a box, or its equivalent containing chloride of lime, muriate of ammonia, and stone lime, so that the *steam becomes impregnated with the principles of those elements prior to entering* the oil.

42,671—May 10, 1864. SYLVESTER LEWIS. *Improvement in deodorizing petroleum, etc.*

Claims the use and application of ashes and charcoal for the purpose of deodorizing petroleum and kerosene oils, naphtha, benzole, and benzene, and the process of filtering the same through the above ingredients, without reference to the exact proportions of such ingredients, which vary somewhat, depending upon the state of the oil to be deodorized.

43,325—June 28, 1864. JOSHUA MERRILL. *Improved mode of purifying hydrocarbon oils.*

Claims in the process of purifying hydrocarbon oils, treating them with sulphate of soda, in combination with the use of caustic or carbonate alkalies.

45,007—November 15, 1864. WILLIAM ADAMSON. *Improved apparatus for purifying mineral oils.*

Claims the mode of purifying mineral oils by mixing the oil with acids or alkalies and washing the mixture with water in a tank or reservoir by means of a paddle wheel.

48,367—June 27, 1865. ROBERT A. CHESEBROUGH. *Improved process for distilling petroleum.*

Claims the combination of bone dust, pulverized oyster shells, and cotton cloth for purifying, filtering, and deodorizing petroleum, naphtha, and heavy oil.

49,502—August 22, 1865. ROBERT A. CHESEBROUGH. *Improved process for purifying coal oil, etc.*

Claims the use of boneblack for purifying petroleum or coal oils by filtration.

51,557—December 19, 1865. ROBERT A. CHESEBROUGH. *Improvement in refining petroleum by filtration.*

Claims the use of peat charcoal, either by itself or in combination with other substances, for purifying or refining petroleum by filtration.

51,558—December 19, 1865. ROBERT A. CHESEBROUGH. *Improvement in refining petroleum by filtration.*

Claims the use of alumina and of substances containing alumina, either by itself or in combination with other substances, for purifying or refining petroleum by filtration.

52,897—February 27, 1866. HENRY T. SLEMMER. *Improvement in the manufacture of lubricating oil.*

The nature of this process consists in returning to the still the heavy products of the distillation of petroleum, denominated "naphthalene" and "paraffine," adding thereto a strong solution of caustic alkalies, either potash, soda, or any *other alkali, and redistilling, steam being introduced when at or near* the boiling point. The first products of the distillation—naphtha—and the lighter naphthalene oil or distillate being removed, the remaining distillate is received in the

receiver. This is then passed into a washer or agitator and thoroughly washed with a hot solution of alkalies, the alkali subsiding and being drawn off. It is then washed with hot water to remove the alkali. The object of the alkali is to remove the free acid produced by the distillation. It is then allowed to subside, the oily product being drawn off into another receiver. This is then frozen to crystallize the naphthalene and paraffine. The oil is then strained from the crystallized products at a temperature of 26° to 40° Fahrenheit. This produces an oil of 30° to 33° Baumé's hydrometer, of grea tlubricating properties, free from gum or acid, and adapted equally well for light or heavy bearings.

And he claims the production of an oil of the gravity as herein set forth and the rejecting of the first products of the distillate until it approximates 38° Baumé's hydrometer, and subsequent washing and treatment, and as a new manufacture, the lubricating oil prepared substantially as described.

53,656—April 8, 1866. ROBERT NEWALL. *Improved method of deodorizing petroleum.*

Claims deodorizing petroleum and other hydrocarbons by treating and washing them with a solution or lye containing chloride of lime, soda ash, and common lime, or their several equivalents, in the proportions stated.

54,192—April 24, 1866. LEANDER M. MOTT. *Improvement in the manufacture of lubricating oil.*

The nature of this invention consists in, first, reducing the oil by evaporation caused by applying steam or heat directly to the boiler containing the oil and heating the same until the desired gravity is obtained, after which to each gallon of oil to be treated is added 5 ounces of common salt, 5 ounces of unslaked lime, 1½ ounces of saltpeter, three-fourths of an ounce of potash, and the whole boiled together until a proper consistency is obtained and the oil is thoroughly deodorized.

54,267—April 24, 1866. JOHN FORDRED. *Improved method of purifying hydrocarbon oils.*

This invention has for its object the substitution of an alkaline preliminary treatment in lieu of the acid process, it being found that when the crude or distilled oils or products are submitted to the previous action of a caustic alkali a very large proportion of the coloring matter and other constituents are separated therefrom, and that, when such partially purified oils are subsequently treated according to the ordinary or any well known method of purification, not only is the subsequent purification facilitated, but the proportions of acid and alkali are materially lessened, and the products obtained are of superior quality.

After the oils have been subjected to any of the foregoing processes of purification or refining, or when such oils have been refined by any other process, the inventor found that a turbidity which is possessed by some of these oils may be removed, and that they may be made bright by filtration through a bed or filter composed of what is known as "Fuller's earth," or that the Fuller's earth may be mixed with the oil and then allowed to subside. The oil will then be found to be much brighter and quite freed from the dull or opaque appearance it originally possessed.

54,978—May 22, 1866. H. K. TAYLOR AND D. M. GRAHAM. *Improvement in treating oils.*

Claims the treatment of petroleums and other similar hydrocarbons by means of nascent hydrochloric acids, chlorine, fluorine, or other equivalent chemical reagent, so as to change the constitution of the oil and purify it; and the use of sulphuric acid, nitric acid, or salts, containing these or either of them, when used in combination with other materials, for the purpose of treating petroleum or other hydrocarbons.

54,984—May 22, 1866. P. WEISENBERGER. *Improved process of refining hydrocarbon oils.*

Claims the process of purifying distilled petroleum to other liquid hydrocarbons, without the aid of any alkalies, by means and with the use of water at 212° F., or approximate degree of temperature.

55,426—June 5, 1866. C. L. MOREHOUSE. *Improved process for preparing stuffing for currying.*

Claims the mode or process of clarifying paraffine oil by the use of a blast of air in jets, for agitating the oil while treating the same with a large proportion of sulphuric acid, thus checking the excess of chemical heat; the use of hot water in washing the oil; and the use of a blast of air from an ice chamber for crystallizing the paraffine.

56,276—July 10, 1866. WM. H. SANGSTER AND THEO. C. SPENCER. *Improvement in distilling petroleum.*

The invention consists in dispensing with the condensing worm or its equivalent now in common use for condensing the vapor of petroleum during the process of distilling, and so constructing and arranging the still that the vapor is brought directly in contact with a moving body of cold water, through which it rises to the top of the tank made to receive it.

59,751—November 20, 1866. H. K. TAYLOR AND D. M. GRAHAM. *Improvement in treating hydrocarbon oils.*

Claims, first, the disposing affinity of sulphuric acid, causing a chemical combination of the gases used with the oil.

Second. The disposing affinity of sulphuric acid in the treatment of hydrocarbons, that its use in connection with other substances, solid, gaseous, or fluid, by means of which the energy combination of these substances or parts of them with the hydrocarbons is very much increased.

Third. Treating oil by means of air and acid gases.

60,290—December 4, 1866. HENRY C. VAN TINE. *Improvement in refining petroleum.*

Claims the refining of petroleum or carbon oil without the aid of artificial heat, by means of the series of operations consisting substantially of the use of sulphuric acid, sulphate of zinc, sugar of lead, and bichromate of potash, or their equivalents, for separating the heavy carbons and impurities, the neutralizing of the acid and washing with water, combined with the subsequent exposure of the oil thus heated in shallow pans to the action of the atmosphere.

60,757—January 1, 1867. ORAZIO LUGO. *Improvement in deodorizing petroleum.*

Claims the use of chromic acid and hypochlorite of soda, or their equivalents, for the purpose of deodorizing offensive smelling kinds of petroleum.

63,749—April 9, 1867. THOMAS RESTIEAUX. *Improvement in deodorizing petroleum.*

The nature of this invention consists in the application of quicksilver in connection with nitric acid, muriatic acid, or a mixture of nitric acid and muriatic acid, or in any other way, to petroleum or any of the products of petroleum.

65,137—May 28, 1867. DEXTER SYMONDS. *Improved mode of purifying and deodorizing oils.*

In the operation the crude oil is placed in a still, and to, say, 30 gallons is added about 10 gallons of strong lime water, in about the proportion of 1 peck of lime to 8 gallons of water, according to the strength of the lime, and sometimes chloride of lime. Heat is applied and is continued until the oil and lime water have been sufficiently agitated, by boiling, to bring all the particles of oil into contact with the lime water, which acts as a disinfectant or neutralizing agent, to neutralize or expel the unpleasant odors from the oil. Before the oil and lime water in the still have reached a boiling point, the lighter portion of such oil begins to pass off, and continues to pass off during the boiling operation. This light oil, in its passage from the still to the condenser, in a state of vapor, passes through water strongly impregnated with lime or chloride of lime, by which it is sufficiently deprived of its unpleasant odor; but the heavy oil is sufficiently deodorized in the still, as it does not pass off in vapor, but remains in the still long enough to be acted upon by the lime water therein.

65,313—May 28, 1867. WILLIAM VAN WYCK. *Improved composition for filtering petroleum, syrups, and other liquids.*

Claims the application of the compound of soluble animal matter, chalk, and wood charcoal, for the purification of petroleum and other oils, sugars, syrups, and molasses, and spirituous liquors, by filtering these substances through the above-mentioned compound, or by any mode equivalent to filtration.

65,999—June 25, 1867. A. M. BURKE AND STEPHEN WRIGHT. *Improved mode of treating hydrocarbon oils.*

Claims the process of consecutively treating oils first by alkali in the still and subsequently by the use of acids in the agitator as a continuation of the said process.

81,071—August 18, 1868. FRANÇOIS LOUIS DE GERBETH. *Improvement in the manufacture of compound oils.*

Claims the production of an oil resembling linseed oil, and applicable to painting and varnish making, from a mixture of petroleum or coal oil, or such like hydrocarbon and rosin oil, such oils being treated with oxidizing agents, ozonized air, galvanic electricity, and driers;

The treating petroleum, coal oil, or similar hydrocarbon oil with oxidizing agents, and galvanic electricity, so as to improve the color;

The production of a spirit similar to turpentine, from a mixture of light petroleum or coal oil, or other similar light hydrocarbon oil or spirit, and light rosin oil or spirit, such oils or spirits being treated with oxidizing agents, ozonized air, and galvanic electricity; and,

The apparatus for the treatment of oils and spirits by means of ozonized air.

88,978—April 13, 1869. CHARLES C. PARSONS. *Improved process of purifying petroleum.*

The invention consists in passing the vapors of the petroleum or other hydrocarbon, while the atmospheric pressure is removed, through a suitable vessel containing either carbonaceous matter or metallic oxides, or both combined.

By exhausting the vapors by an air pump or suitable means, so placed that the vessel containing the purifying material shall be between it and the still, the vapors are drawn through the purifying material without any increase of pressure, thus at a low temperature, and without the injury resulting from overheating.

For a purifying material, for ordinary petroleum, either wood or animal charcoal, in as fine a state of division as will permit the free passage of the vapors, is preferred. When the hydrocarbons contain sulphur or other specially deleterious substances, oxide of iron, calcium, or other metals may be used, either by themselves or in combination with the charcoal.

91,654—June 22, 1869. THOMAS E. MERRICK. *Improved lubricating oil from petroleum.*

Claims the process of first removing by distillation the lighter products of crude petroleum oil until the gravity is reduced to any gravity between thirty-five (35) and twenty-five (25) Baumé, and then treating it with sulphuric acid, hot water, alkali of caustic soda, or soda ash, and water in the prescribed proportions.

99,728—February 8, 1870. JOSEPH A. TATRO. *Improved process of treating petroleum.*

Having distilled the crude oil, driving over everything that will go over in the worm of the still, and having, say, 100 gallons of product, take from one-fourth per cent to 2 per cent of sulphuric acid and pour it into the whole product and mix thoroughly. When thoroughly mixed, then add lime, partially or wholly slaked, in almost a dry state, sprinkling it over the oil and allowing it to subside into the oil and act upon it. The quantity of lime added is about 3 per centum. Gases will now rise through the oil, the mass meanwhile being stirred. When the gas ceases to rise, add 3 per centum more of lime, in all about 6 per centum. The lime and the gas evolved therefrom combine with those ingredients of the oil which render it dangerously inflammable and raise the fire point to a perfectly safe degree, from 140° to 160° Fahrenheit, according to the duration and strength of the chemical action.

101,284—March 29, 1870. OSCAR LOEW. *Improved method of bleaching and refining oils.*

Claims a cold process for bleaching and refining animal, vegetable, and mineral oils.

106,233—August 9, 1870. JOSEPH A. TATRO. *Improvement in refining petroleum.*

Claims the process described of applying in about the proportion specified to the whole product arising from the distillation of crude petroleum, sulphuric acid, and chloride of lime.

110,054—December 13, 1870. GEORGE LUPTON. *Improvement in purifying benzine.*

Claims the following process:

To forty (40) gallons of benzine add ten (10) pounds of hydrated sesquioxide of iron and ten (10) pounds of hydrate of lime. This mixture should be thoroughly agitated and allowed to stand twenty-four hours. The fluid should then be drawn off and eight (8) ounces of chloride of barium added to it, and the mixture again agitated and allowed to settle. After that one (1) pound of carbonate of soda is thrown in and well mixed with the fluid. Ten (10) pounds of refined paraffine is next dissolved in the fluid, which should stand four or five days before being used.

113,782—April 18, 1871. ROBERT G. LOFTUS. *Improvement in the purifications of oils and fats by acids.*

This relates to the treatment of rosin oil, and claims:

The employment of naphtha or a solvent in the process of treating oil with acid and alkali, and subsequently subjecting the treated oil to the action of steam in a still, or to distillation, all substantially as and for the purpose of separating the solvent from the oil.

116,852—July 11, 1871. CHARLES C. MENGEL AND ALOIS PÖHR VON PÖHRNHOFF. *Improvement in converting the residuum of petroleum into oil.*

Claims the conversion of the tarry residuum of petroleum distillation into illuminating oils by dropping into it water in a liquid state, or liquids containing water, while it is subjected to a high degree of heat in a still.

125,067—March 26, 1872. CHARLES C. MENGEL AND ALOIS P. VON PÖHRNHOFF. *Improvement in the manufacture of illuminating oils.*

Claims the manufacture of illuminating oil from crude oil without having recourse to lead and sulphur to effect its deodorization, by introducing water in a liquid state, or liquids containing water, drop by drop, onto the surface of the heated oil in the still and afterwards condensing the vapors thus eliminated and passed off from the still.

127,446—June 4, 1872. JAMES YOUNG. *Improvement in treating petroleum and other hydrocarbon oils.*

Claims the treatment of petroleums and paraffine oil with muriatic or hydrochloric acid.

139,009—May 20, 1873. JOHN JAY LOONEY. *Improvement in treating heavy petroleum.*

Claims the treatment of crude or heavy petroleum, previous to distillation, with a compound or mixture of benzine and sulphuric acid.

146,405—January 13, 1874. EMIL SCHALK. *Improvement in refining petroleum and other oils.*

Claims the process of refining distilled petroleum by sulphurous acid and ammonia gas.

161,472—April 6, 1875. HENRY DUBBS. *Improvement in compounds for decolorizing petroleum.*

Claims the improved compound for decolorizing petroleum or other oils, consisting of lime and sawdust combined.

164,694—June 22, 1875. AUGUSTUS T. SCHMIDT. *Improvement in refining oils.*

Claims in refining oils the process of subjecting the oils to distillation in the presence of a sulphite or hyposulphite, and in treating oils, the process of washing the distillate in a bath of water holding a hyposulphite or hypophosphite in solution.

216,518—June 17, 1879. HENRY F. HOWELL. *Improvement in processes of converting crude petroleum, without practically changing its volume, into a uniform, purified, and deodorized oil, which may be distilled without the coming over of naphtha, etc.*

Claims the process of converting crude petroleum and analogous oils into a substantially uniform fluid of the same homologous series, practically without changing its volume, which consists in subjecting the crude oil to the action of chlorine gas, whereby a certain proportion of the hydrogen element is replaced by an equivalent of the gas.

240,094—April 12, 1881. MARTIN CONNELLY. *Process of deodorizing and refining petroleum.*

Claims the process of deodorizing crude petroleum, consisting in heating the petroleum in an open vessel, and in suspending the deodorizing materials in a solid state in the oil, and heating together the oil and said suspended materials, and afterwards withdrawing the said deodorizing materials in a body from the oil.

240,094—April 12, 1881. MARTIN CONNELLY. *Petroleum products and process of obtaining and deodorizing the same.*

Claims the process of treating crude petroleum for the obtaining therefrom of an odorless anhydrous oil, consisting in first heating the petroleum in its natural state until it is freed of water, and afterwards introducing anhydrous or unslaked lime (calcium oxide) in proportions substantially such as specified, and heating said lime and oil together while entirely isolated from other materials, and finally separating the lime from the oil, whereby the oil is left without any foreign materials therein.

257,961—May 16, 1882. THOMSON McGOWAN. *Process of and mechanism for distilling hydrocarbons.*

Claims the process for the removal of sulphur from petroleum consisting in introducing oxygen and an alkali simultaneously into the body of the petroleum during distillation and when the temperature thereof is 300° F. or above.

275,505—April 10, 1883. HANS BRACKEBUSCH. *Process of deodorizing solutions of colophony in heavy hydrocarbons.*

Claims the process of deodorizing and refining solutions of colophony in heavy hydrocarbons, which consists in treating the same with nitric acid and neutralizing the nitro combinations resulting from the reaction by means of sulphuric acid and iron filings, substantially as and for the purposes specified, and in or about in the proportions set forth.

289,788—December 4, 1883. HEINRICH UJHELY. *Process of decolorizing and deodorizing heavy mineral oils.*

Claims the process of decolorizing and deodorizing heavy mineral oils, which consists in dissolving them in light hydrocarbon oils, adding to the solution the insoluble residuum obtained in the manufacture of ferrocyanide of potassium, boiling the mixture, filtering the same, and finally distilling from the filtrate the hydrocarbon solvent.

299,167—May 27, 1884. JOHN ROWSELL. *Process of bleaching, deodorizing, and sweetening benzine.*

Claims the process of deodorizing, etc., petroleum benzine wherein a given mass of the same is first treated to an application of sulphuric acid, then to a solution of a suitable alkali, and lastly to a solution of saltpeter and sulphuric acid, a washing with water being preferably resorted to after and between each of the aforesaid applications, said chemicals being used in the proportions and in the manner specified.

299,524—May 27, 1884. RICHARD BAYNES AND JOHN FEARENSIDE, JR. *Process of purifying or refining petroleum and other distillable oils.*

Claims the process of bleaching and purifying dark-colored distillable oils, which consists in adding to the oil pulverized dry coke or charcoal impregnated with anhydrous chloride of zinc till it arrives at the consistency of mud, subjecting it to distillation, and then condensing the distillate.

305,180—September 16, 1884. HALVOR HALVORSON. *Method of dividing and distilling crude petroleum.*

Claims the process for dividing crude petroleum into two parts, designated "primary" and "secondary" oils, which consists in mixing together crude petroleum and benzine and volatilizing the benzine, whereby it is caused to carry over with it the primary oil, leaving the secondary oil behind.

312,605—February 24, 1885. LEON BLUMENTHAL. *Eliminating the smell of coal oil.*

Claims the process of eliminating the odorous impurities from refined kerosene, which consists in, first, subjecting the liquid to the action of induced air currents; second, adding about 1 dram of sulphuric ether to each gallon of the product; and, third, continuing the action of the air currents.

321,466—July 7, 1885. JULIUS H. TIEMANN. *Process of refining petroleum.*

Claims the process of removing sulphuric acid from petroleum distillates and producing a finished merchantable product, which consists in adding directly to such distillates—that is, next after the acid treatment—an anhydrous alkali, or alkaline earth or composition thereof, or an anhydrous compound of the metals, whereby any washing is avoided.

330,637—November 17, 1885. JULIUS H. TIEMANN. *Process of purifying petroleum.*

Claims in refining petroleum the method of effecting more immediate and intimate contact of the acid, which consists in diffusing or spreading the acid by mixing with the petroleum and acid a powdered siliceous or other inorganic substance of greater specific gravity than the oil, and which is insoluble in or unaffected chemically by the acid.

336,941—March 2, 1886. JAMES W. NORTON AND FRANKLIN H. ROUSE. *Process of and apparatus for distilling oil.*

Claims the oil still provided with a closed top having an opening, in combination with the condensing chamber arranged longitudinally above the still and connecting directly with the opening in which the hot air, gases, and vapors are received, and a reduced portion combined and communicating with the outlet end of the body portion and connecting with an exhaust power to withdraw the water, gas, and air, and pipes arranged in the enlarged portion, and adapted, respectively, to spray water and liquid chemicals on the hot air and gases, with receptacles for supply water and liquid chemicals thereto, and

The method of distilling petroleum oil, consisting of heating the oil at the bottom of the still, forcing hot air downward through the body of oil to give thereto a lateral motion, causing chemicals to be precipitated or mixed thoroughly with the oil by this action of the hot air, subjecting the gases, etc., arising from the body of oil to the combined action of chemicals and water spray in a condensing chamber, the water and chemicals thus mingling with the gases, and conveying the same into a receiving tank.

340,411—April 20, 1886. CHARLES LEOPOLD BAILLARD. *Process of treating mineral oils.*

Claims the process of oxidating mineral oils by treating the same with oleic acid of distillation or saponification, or with rancid oil or fat.

342,564—May 25, 1886. GEORGE L. BENTON. *Process of refining crude petroleum oil.*

Claims the process of refining crude petroleum, which consists in heating the oil to a temperature ranging from about 700° to 1,000° Fahrenheit, and under a pressure of about 500 pounds or more to the square inch, then causing the heated oil to expand into a chamber of approximately the same temperature, and finally conducting it into an ordinary apparatus wherein it is condensed.

370,950—October 4, 1887. DANIEL MACDUGALD KENNEDY. *Desulphurizing and purifying petroleum oils.*

Claims the process of combining the sulphur in the oil with the metallic matter contained in a solution of about equal quantities of sulphate of copper (blue vitriol), caustic soda, and chloride of sodium (common salt), and then separating such combined metallic matter and sulphur from the oil.

378,246—February 21, 1888. HERMAN FRASCH. *Refining Canadian and similar petroleum oils.*

Claims the process of purifying Canadian and similar petroleum oils which contain sulphur compounds whose presence gives to said oil the property of dissolving lead oxide by distilling the same with the oxidating oxides, especially the roasted and oxidated residues of previous operations, mixed with or dissolved in the oil under treatment.

379,492—March 13, 1888. WILLIAM H. PITT. *Process of distilling petroleum.*

Claims the process of distilling petroleum having sulphurous or other offensive odors, consisting essentially of vaporizing such liquid petroleum, then passing the vapors so formed through a receptacle heated at the same or a higher temperature than the vapors coming from the still, said receptacle being filled with a metal or metals—such as iron or metallic compounds—having an affinity for the sulphurous vapors and other objectionable compounds, whereby they are held and retained by such substance, and conducting away and condensing the balance of the vapors.

400,633—April 2, 1889. FRANCIS M. F. CAZIN. *Method of refining and deodorizing coal oil or petroleum.*

Claims the process of deodorizing oil, consisting in first passing the same in a finely divided state through water; second, passing the same through an alkaline solution; third, passing the same through a solution of a salt of a heavy metal; fourth, passing the same through a solution of sulphuric acid; fifth, passing the same through an alkaline solution, and ultimately washing the same.

407,183—July 16, 1889. JESSE A. DUBBS. *Process of refining oils.*

Claims as an improvement in the art of refining oils containing sulphur, the herein described method, which consists in adding arsenium or its salts to the oil, subjecting the compound to a volatilizing heat, and then condensing the vapors so produced, substantially as set forth.

407,874—July 16, 1889. HENRY R. ANGUS. *Process of purifying and devolatilizing petroleum distillates.*

Claims the process of obtaining purified and graded oils and naphthas from petroleum distillate, consisting in repeatedly subjecting the distillate to the action of heated water in closed tanks at increasing temperatures by passing the distillate upwardly through the heated water in said tanks, separately removing the volatilized product of each tank as the process advances, and condensing and discharging said products separated from each other and from the distillate.

408,472—August 6, 1889. JOHN KINGSFORD FIELD. *Process of refining mineral oil.*

Claims the method of refining mineral oil, which consists in acidifying the oil with fuming sulphuric acid, then subjecting it to agitation in connection with bleaching material, then again acidifying with sulphuric acid, and again subjecting to agitation in connection with bleaching material.

413,187—October 22, 1889. EDWARD D. KENDALL. *Process of freeing malodorous hydrocarbons from offensive odor.*

Claims the process of freeing malodorous hydrocarbons from offensive odor, which consists in subjecting the same to the action of chloride of sulphur.

414,601—November 5, 1889. LEVI STEVENS. *Process of distilling oils and oleaginous substances.*

Claims the process of distilling oils, which consists in admixing the same with steam, passing the compound through a molten mass of material, which will liquefy but not volatilize at a temperature sufficient to break up and volatilize the heavier products of the oil, and finally condensing the resultant vapor.

The process of distilling oils and oleaginous compounds, which consists in admixing the same with steam, vaporizing the compound, conducting the resulting vapor through a series of condensers, in each of which in succession it is subjected to a lower temperature, and drawing off the product of condensation from each condenser into a still or vessel heated to a temperature at which said product shall be redistilled to expel therefrom the lighter products, which may have been carried with it from the condenser.

419,347—January 14, 1890. ROBERT MILTON PERRINE. *Process of purifying and deodorizing crude petroleum.*

Claims the process of deodorizing and purifying crude petroleum oils, which consists in first agitating or stirring the same with chloride of lime for a period of five hours, more or less, and then adding sulphuric acid to complete the elimination of chlorine gas and to neutralize and precipitate the alkaline matters and other impurities, and finally drawing off or removing the purified and deodorized oil.

425,905—April 15, 1890. CHARLES RAVE. *Process of utilizing acid tar residuums.*

Claims the process of manufacturing bitumen and other products from crude oils, tars, pitches, and other hydrocarbonaceous matters, which consists in treating the crude hydrocarbons with sulphuric acid at a suitable temperature, thus forming clear oil or grease and an acid tar, macerating the acid tar with water and granular metal, such as described, out of contact with air, till the sulphuric acid and metal have combined, distilling the bitumen by fractional distillation, obtaining thereby various naphthas and oils till the residue is sufficiently hard for the purpose required.

440,880—November 18, 1890. ANSON L. MUNSON. *Process of treating coal tar.*

Claims the process of treating coal tar, which consists in subjecting the coal tar to a heat of 110° Fahrenheit, maintaining that heat without driving off the lighter volatiles until the solids are melted to a degree sufficient to be acted upon by the solvents, adding a saturated solution of chloride of zinc in the proportion of 2½ pounds to every 50 gallons of tar, and agitating the mass, then adding oil of turpentine during the agitation in the proportion of 5 gallons to every 50 gallons of tar, and continuing the agitation until the turpentine is thoroughly incorporated.

442,803—December 16, 1890. JOHN GARDNER AND JAMES F. HARRIS. *Process of refining hydrocarbon oils.*

Claims the process of refining oils, which consists in injecting a ferruginated liquid into a vaporizing chamber, intimately commingling a spray of oil therewith and vaporizing the same, condensing the vapors, and separating the sulphur compounds.

448,480—March 17, 1891. HERMAN FRASCH. *Process of and apparatus for refining and purifying petroleum.*

Claims the process of removing from petroleum the sulphur compound known as "skunk," consisting in vaporizing the petroleum and passing the vapors through a vessel containing an oily liquid holding in solution, or solution and suspension, a substance soluble in such petroleum and having an affinity for the skunk compound, and raising the solution into contact with the vapors above the liquid by causing a device to enter repeatedly into and agitate the liquid and raise upon the surface of the device a portion of the liquid into the space occupied by the vapors.

451,660—May 5, 1891. EDWARD DWIGHT KENDALL. *Process of refining hydrocarbons.*

Claims the process of purifying mineral hydrocarbon oils containing sulphur compounds, which consists in mixing the oil with mercuric chloride in solution and in subsequently removing the absorbed mercuric body from the oil by subjecting the oil to the action of a suitable sulphide.

451,784—May 5, 1891. THOMAS J. GORDON. *Process of purifying petroleum distillates.*

Claims the process of purifying petroleum distillates, which consists, first, in subjecting the same to the action of a chemical having an affinity for sulphur products, such as litharge, then admixing with the distillate thus treated sulphate of magnesium to precipitate the sulphur products and litharge, then adding an acid to precipitate the remaining sulphur and lead products, then adding an alkaline solution to neutralize the acid, and finally washing the distillate to remove the alkali.

465,708—December 22, 1891. CHARLES C. MENGEL, SR. *Process of refining petroleum and analogous oils.*

Claims the process of refining petroleum and analogous oils, consisting in vaporizing the oils, introducing into the vapor previously washed carbonic acid gas under pressure and in a heated state, conducting the mixture into extended pipes, subjecting the same to additional heat, and discharging the mixture into a condenser.

480,311—August 2, 1892. OTTO P. AMEND AND JOSIAH H. MACY. *Process of desulphurizing oils.*

Claims the process of desulphurizing oil, which consists in vaporizing the oil containing the sulphur and heating the oil vapor to a degree of heat at or above the boiling point of sulphur, exposing the oil vapor so heated to the action of one or more chemical reagents that will combine with sulphur or sulphur compounds, and then condensing the oil vapor.

480,312—August 2, 1892. OTTO P. AMEND. *Process of desulphurizing oils.*

Claims the process of desulphurizing oil, which consists in vaporizing the oil containing sulphur or sulphur compounds and heating the vaporized oil to a degree of heat at or above the boiling point of sulphur and then exposing the vaporized oil so heated to the action of one or more alkalies and then condensing the oil.

487,119—November 29, 1892. HERMAN FRASCH. *Refining Canadian or similar petroleum oils.*

Claims the process of removing the sulphur compound termed "skunk" from Canadian and similar petroleum, which consists in vaporizing the oil and subjecting the vapors after they are given off from the body of the oil to the action of an oily or resinous liquid holding in solution or solution and suspension one or more metallic oxides soluble in said oil, including the decomposable compounds of such oxides, and condensing such purified vapors.

487,216—November 29, 1892. HERMAN FRASCH. *Purifying petroleum.*

Claims the process of purifying petroleum of the Canadian and Lima class of distilling the said skunk bearing petroleum and subjecting the same to the action within the oil undergoing distillation of the salts of those metals which are precipitable by hydrogen sulphide in acid solution, as the manganates, chromates, borates, sulphates, carbonates, and the like.

501,988—July 25, 1893. FRANCIS J. CARMAN. *Process of refining sulphurous petroleum.*

Claims the process for desulphurizing oils, which consists in passing the oil vapors through a receptacle containing a mass of melted metal, which will reduce the sulphurous vapors to a common form of combination, and then combine with the sulphur.

503,028—August 8, 1893. GEORGE ARCHBOLD. *Method of and means for extracting hydrocarbons from bituminous rocks.*

Claims the method of separating earthy matters from the hydrocarbons in bituminous rock, consisting in subjecting a mass of said rock to the action of sulphurous acid.

507,441—October 24, 1893. HERMANN KOEHLER. *Process of refining petroleum.*

Claims the process of treating hydrocarbon oils which are impregnated with sulphur or sulphur compounds, for the purpose of preparing the oil for the removal of the sulphur by subsequent treatment, consisting in the following steps: First, vaporizing the oil by subjecting it to heat in a still; second, passing the vapors thus produced through lime heated to such a temperature that whitish visible vapors are evolved; and, third, condensing the vapor after its passage through the heated lime.

508,479—November 14, 1893. ADOLF KAYSER. *Method of deodorizing hydrocarbon oils.*

Claims the method of deodorizing hydrocarbon oils which consists in subjecting their vapors to the action of anhydrous nitric acid, either alone or in connection with hypochlorous acid.

522,028—June 26, 1894. WALTER B. PRICE. *Process of purifying illuminating oils.*

Claims a new process of purifying oils containing sulphur, which consists in treating the oil with nitric acid, nitrous acid, or nitric peroxide, and distilling the oil so treated with sulphuric acid.

523,716—July 31, 1894. ADOLPH SOMMER. *Process of desulphurizing mineral oils.*

Claims the improvement in the process of desulphurizing mineral oils consisting in volatilizing the same and passing their vapors through a body of anhydrous sulphate of copper, heated to a temperature about or above 130° centigrade.

525,811—September 11, 1894. HANS A. FRASCH. *Process of refining petroleum.*

Claims the process of refining petroleum or its distillates, which consists in transforming the sulphur and basic bodies contained therein into oxidized and chloric products by treatment with a substance containing free chlorine or chloric oxide, removing the soluble compounds by washing with water, taking up the compounds soluble in acid by treatment with sulphuric acid, converting the remaining chloric bodies into a double salt, which is insoluble in the soil, by treatment with a basic metallic salt, and finally removing such double salt by decantation or otherwise.

525,969—September 11, 1894. ADOLPH SOMMER. *Process of desulphurizing mineral oils.*

Claims the herein described improvement in the process of desulphurizing mineral oils, consisting in digesting them with dry sulphate of copper.

534,295—February 19, 1895. JULIUS J. SUCKERT. *Process of purifying hydrocarbon oils.*

Claims the process of refining hydrocarbon oil, consisting in adding to the same a body described capable of combining with sulphur in the oil, subjecting the mixture to heat and pressure, subsequently relieving said pressure and condensing any vapors arising from the heated oil.

537,121—April 9, 1895. CLEMENS LOSSEN. *Deodorizing mineral oils.*

Claims the process of deodorizing mineral oils, which consists in mixing the oils with cuprous oxide and then subjecting the mixture to heat until the acetylenes contained therein are destroyed.

542,849—July 16, 1895. HERMAN FRASCH. *Process of refining petroleum.*

Claims the process of purifying petroleum of the Canadian or Lima class from sulphur compounds consisting in subjecting such sulphur bearing petroleum to the action of nitrous acid fumes at the temperature and during the process of distillation.

543,619—July 30, 1895. HERMAN FRASCH. *Refining Canadian or similar petroleum.*

Claims the process of removing the sulphur compound termed "skunk" from Canadian and similar petroleum, which consists in vaporizing the oil and subjecting the skunk bearing vapors given off from the body of oil to the action in an undissolved condition of one or more of the oxides or oxygen salts of the metals of that class which are precipitated by hydrogen sulphide in acid solution and which form oxides soluble in skunk bearing oil.

548,891—October 22, 1895. WALTER B. PRICE. *Method of purification of mineral oils.*

Claims the improvement in the process of purifying California illuminating oils, which consists in treating the oil to be purified with strong sulphuric acid, at a temperature above the boiling point of water.

551,941—December 24, 1895. OTTO P. AMEND AND JOSIAH H. MACY. *Process of desulphuring petroleum distillates.*

Claims the process of eliminating sulphur or organic sulphur compounds from petroleum oil or distillate, which consists in subjecting the oil or distillate containing sulphur or organic sulphur compounds to the action of an oxide or hydrate of an alkali or alkaline earth or to a combination of both oxide and hydrate by bringing the same in contact each with the other and agitating them or one of them; in heating the oil or distillate and the contents thereof; in effecting the dehydration of the oil or distillate by introducing therein and agitating therewith one or more dehydrating agents, as terra alba (oxide of alumina), calcium oxide or other dehydrating agent, and precipitating the new sulphur compounds, which are formed by the action of the alkali or alkaline earth upon the sulphur or organic sulphur compounds in the oil, and then separating the oil or distillate from the precipitate.

558,747—April 21, 1896. CARLOS A. SMITH. *Process of refining oil.*

Claims in the process of refining sulphur petroleums the improvement consisting in exposing the crude distillate of such sulphur petroleum to the influence of an active plate or element, such as lead, and an inactive plate or element, such as carbon and then treating with an acid in the usual way.

560,463—May 19, 1896. FRIEDRICH BERG. *Refining petroleum or hydrocarbon oils.*

Claims in refining crude Ohio petroleum or other like sulphurous hydrocarbon oils, the process consisting in treating the crude oil prior to the distillation of the illuminating oil products, first, with a suitable acid, and, secondly, with a suitable alkali or base, all at a temperature of at least 110° Fahrenheit.

561,216—June 2, 1896. HERMAN FRASCH. *Distillation of petroleum.*

Claims the improvement in the distillation of petroleum, consisting in taking the distillate obtained by cracking heavier oils, and after the so obtained distillate has been treated with sulphuric acid redistilling the same with diffusion of alkaline material, such as lime, through the said distillate, the diffusion of the said material being effected through the whole body of the oil while this is suitably below the boiling point of water and continued through the subsequent rise of temperature to the boiling point of oil and the consequent evaporation of the said oil, so that said material is exhibited to the compounds which resulted from the action of the sulphuric acid upon the cracked oil as the same are decomposing from the commencement throughout the progress of the decomposition.

564,921—July 28, 1896. HERMAN FRASCH. *Art of purifying petroleum.*

Claims in the purification of petroleum, the improvement consisting in heating through hot gases of combustion a number of independent charges of small diameter of a purifying agent to an elevated desulphurizing temperature which is the same for the different charges, equalizing such temperature through the absorption and giving off of heat by a regulator between the charges of purifying material and the fire, dividing the vapors given off together from the same body of petroleum in distillation into a number of streams, subjecting these several streams separately each to the action of the purifying agent in one of said charges, and making such action alike on the different streams by forming a partial vacuum between the purifying agent and the condenser and thereby counteracting differences in the resistance of the several charges.

564,922—July 28, 1896. HERMAN FRASCH. *Process of and apparatus for refining Lima or similar petroleum.*

Claims the continuous process of removing skunk from Lima or similar petroleum, consisting in exposing a comminuted oxide or salt of copper or like metal to the vapors of such oil and (when the said substance is charged with sulphur) to air so as to revivify the same by oxidation of the metal and sulphur, all under the conditions of a noncaking temperature and an absence of compacting pressure, and then repeating the described operations under said conditions of heat and pressure, without removal of the said substance from the apparatus in which the process is carried on by the passage of skunk bearing vapors to decompose the skunk and of air to revivify the skunk decomposing substance.

564,923—July 28, 1896. HERMAN FRASCH. *Process of refining Lima or similar petroleum.*

Claims the continuous process of removing skunk from Lima or similar petroleum, consisting in exposing a purificator composed of a refractory fibrous material like woolly asbestos and a comminuted oxide of salt of copper or like metal adherent to the fibers of such material to the vapors of such oil and (when the substance is charged with sulphur) to air so as to revivify the substance by oxidation of the metal and sulphur, all under the conditions of a noncaking temperature and an absence of compacting pressure so as to induce or retain a swelled or expanded state of extreme subdivision in the substance which adheres to the refractory fibers, and repeating the described operations under said conditions of heat and pressure, without removal of said purificator from the apparatus in which the process is carried on by the passage of skunk bearing vapors to decompose the skunk and of air to revivify the skunk decomposing substance.

564,924—July 28, 1896. HERMAN FRASCH. *Process of and apparatus for refining Lima or similar petroleum.*

Claims the improvement in refining Lima or similar petroleum, consisting in burning the spent skunk decomposing substance for the purpose of revivification, keeping the degree of heat below a caking temperature by conducting away the excess of heat as generated by means of the oil in distillation, and conveying away and condensing the so generated vapors; and,

The combination with a still and a distilling chamber of a purifier box adapted to serve also as a revivifying furnace arranged in said chamber, a vapor pipe between the said box and the vapor space of said still (whether said pipe be or be not also in communication with the vapor space of said chamber), one or more air inlet pipes for said box, means for opening and closing said pipes, a condenser, a condenser connection for the said box, and a separate condenser connection for the said chamber (the last-mentioned connection being preferably by way of a companion purifier box).

565,039—August 4, 1896. GEORGE M. SAYBOLT. *Process of refining hydrocarbon oils.*

Claims the method of purifying petroleum distillate, which consists in treating it, after final distillation, with nonfuming sulphuric acid, and then removing the impurities remaining after the acid treatment by bringing the distillate into intimate contact with a finely divided, substantially nonalkaline substance without intermediate treatment of the distillate with water or alkali.

565,040—August 4, 1896. GEORGE M. SAYBOLT. *Process of refining petroleum distillates.*

Claims the method of purifying petroleum distillate, which consists in treating the burning oil distillate of petroleum of less than 0.850 specific gravity, after its final distillation, with nonfuming sulphuric acid, and removing the impurities remaining after the acid treatment by agitating such distillate with water and then agitating it with finely divided nonalkaline solid material, and thereby removing the sulphonic salts produced by reaction of the sulphuric acid with the oil.

572,676—December 8, 1896. HERMAN FRASCH. *Treatment of petroleum for removing sulphur compounds.*

Claims the process of treating oil of the Lima class, for removal of the skunk, by subjecting the skunk bearing oil during a distillation thereof to a pulverulent purifying material of metallic oxide having a basis of iron and copper in the intimate union resulting from a melting together of their compounds and admixture in the molten state and consisting of roasted and pulverized copper matte, the purifying material being used in the body of oil in distillation or brought into contact with the vapors after they have been given off from said body.

580,652—April 13, 1897. MAX SCHILLER. *Method of refining and purifying hydrocarbon oils.*

Claims the process of removing sulphur compounds from hydrocarbon oils, which consists in mixing the crude oil with zinc dust and substantially dry alkaline hydrate for the production of hydrogen to combine with the sulphur of said sulphur compounds, the proportion of zinc dust and alkaline hydrate being in excess of that required for the separation of hydrogen to combine with the sulphur compounds, and subjecting the same to the distilling operation.

583,779—June 1, 1897. JAMES R. WHITING AND WILLIAM A. LAWRENCE. *Process of and apparatus for deodorizing oils.*

Claims a process of deodorizing oil, consisting in first reducing the oil to a vapor, then passing said vapor through charcoal, then through limewater, and then condensing said vapor.

An apparatus for deodorizing the lighter products of coal or petroleum, comprising a heating cylinder, in which the material under treatment is to be vaporized, a container for charcoal having communication with said cylinder, a limewater cylinder communicating with the container, and a condenser communicating with said limewater cylinder.

586,520—July 13, 1897. GEORGE H. MOORE. *Process of refining petroleum*

Claims the process of purifying Lima and Canadian petroleum oils, and petroleums of that class, by removing the nitrogenous compounds and traces of the phenylic and naphthalene series by means of a porous compound of sodic hydrate, calcic hydrate, and sulphate of soda applied to vapor of the oil previous to the removal of the sulphur.

595,788—December 21, 1897. HENRY J. SMALL AND HOWARD STILLMAN. *Apparatus for manufacturing benzene.*

The object of this invention is to effect the utilization of the liquid benzol which is obtained as a by-product in the operation of the "Pintsch gas" plant by the manufacture therefrom of benzene in a simple and inexpensive manner; and the inventor claims—

In an apparatus for the manufacture of benzene, the combination of an agitator, a compressed air supply pipe, a steam still, a condenser, and valved connections from the agitator to the still, from the agitator to a point of discharge, and from a source of compressed air to the agitator.

596,437—December 28, 1897. WILLIAM A. SMITH. *Process of refining oil.*

Claims in a process of refining refractory oils the following steps: Introducing terpene into the oil or distillate to be refined, subjecting the mixture to heat and removing terpene, whereby the oil or distillate is rendered amenable to further treatment.

597,920—January 25, 1898. ERIC A. STARKE. *Process of purifying and refining California petroleum oils.*

Claims the process of treating, purifying, and refining "California" petroleum oils, so as to produce from them illuminating oils, which process consists, essentially, in first removing the less refractory substances by treating said oils with a solvent or menstruum and then treating the resulting product with sulphuric anhydrid to remove the more refractory substances.

601,331—March 29, 1898. OTTO P. AMEND. *Process of desulphurizing refractory oils.*

Claims the process of desulphurizing and treating petroleum oil or distillate containing refractory sulphur compounds, as Lima or Canadian oil or distillate, which consists in treating the oil or distillate with sulphuric acid having a higher percentage of H_2SO_4 than is found in ordinary commercial 66° Baumé acid and containing SO_3 or anhydrous sulphuric acid; in repeating the application of such acid until a splitting up of the sulphur compounds in the oil or distillate is effected; then removing the acid sludge and exposing the split up sulphur compounds to the action of an agent or reagent having an affinity for sulphur; and in effecting the dehydration of the distillate.

604,280—May 17, 1898. HERMAN WOLF. *Process of and apparatus for refining crude petroleum, etc.*

Claims the process of refining petroleum and analogous oils, which consists in injecting a stream of sulphuric acid between two streams (one of which is oil) moving at different velocities; and,

A refining apparatus comprising a cylindrical casing provided with concentric inlet or injection nozzles and having a constricted portion above the nozzle mouths and below the upper extremity of the casing, said casing having its upper portion provided with a lid and its lower portion provided with lateral inlets.

604,515—May 24, 1898. JOHN BRAGG. *Process of deodorizing and purifying petroleum oil.*

Claims the process of deodorizing and purifying petroleum oil, which consists in first dissolving in the oil a metallic compound soluble in the oil and whose metallic constituent is combinable with the sulphur element of the oil, such, for instance, as an oleate or colophonate, subsequently breaking up the compound or emulsion thus formed by the addition thereto of a substance capable of reacting with the metallic element of the compound added, whereby the metallic constituents of the mass are caused to separate from the oil, and finally removing from the oil the separated impurities and precipitates, without distillation.

607,017—July 12, 1898. THEODORE F. COLIN. *Process of desulphurizing petroleum.*

Claims the process of purifying Ohio and similar petroleum oils, which consists in distilling the crude oil or distillate with a peroxid, from which the oxygen is liberated in the presence of the hydrocarbons at the normal temperature of distillation.

618,307—January 24, 1899. AUGUST WENDTLAND. *Process of removing green color from paraffin.*

Claims a process for removing the green color from petroleum residues which have been treated with sulphuric acid, which consists in treating the same with a soap composed of fatty acid and an alkaline solution, allowing the soapy and oily matters to separate, treating the oily portion with barium chlorid solution, and filtering such oily portion through boneblack which has been impregnated with alcohol.

620,882—March 14, 1899. ARTHUR J. BOOTE AND HENRY G. W. KITTREDGE. *Process of treating hydrocarbon oils for removing sulphur compounds.*

Claims in the treatment of oils for the removal of sulphur compounds contained therein, the method of first treating the oil with an alkaline solution of an oxid of lead, and then further treating it with a hypochlorite of calcium, and then removing the precipitate.

622,799—April 11, 1899. HERMAN FRASCH. *Process of and apparatus for purifying petroleum.*

Claims as an improvement in the art of purifying petroleums of the Canadian or Lima class, for the removal of the offensive sulphur compound contained therein, passing the vapors of distillation through a column or vessel containing metallic purifying material in divided particles, such vessel being revolved or agitated constantly or intermittently during the passage of the vapor therethrough for the purpose of removing from their surfaces, by the abrasion on each other of the particles of the purificator, the metallic sulphide which is formed thereon; and,

The combination with a petroleum still and a condenser of an agitatory or rotatory vessel for containing and cleansing a purificator interposed in the path of the vapors between the said still and condenser, and means for heating said vessel.

623,066—April 11, 1899. FREIDRICH BERG. *Process of refining petroleum.*

Claims the petroleum refining process comprising, first, a treatment of the crude oil with an alkali at a comparatively high temperature, maintaining this mixture at said temperature for several hours and stirring or agitating the mixture at intervals during this time; then removing or separating the alkali and foreign matter that has been precipitated or settled during said alkali treatment and permitting the alkali still contained in the oil to stand for several days at a moderate temperature and continue its work of destroying sulphurous compounds and impurities still remaining in the oil; then distilling the oil, and, finally, treating the distillate with sulphuric acid for the purpose of removing the water contained in the distillate.

640,918—January 9, 1900. ADOLPH KAYSER. *Method of refining petroleum and petroleum derivatives.*

Claims in the method of refining ill smelling or sulphur bearing petroleum, or petroleum derivatives, the step which consists in distilling the same by the application of heat to the still, mixing carbon with the oil vapor, and heating the mixture of oil vapor and carbon monoxid to the temperature necessary for causing the carbon monoxid to react upon the objectionable compounds in the oil vapor.

649,047—May 8, 1900. HERMAN FRASCH. *Art of purifying petroleum and products therefrom.*

Claims the process of making from Lima or Canadian petroleums, which contain the sulphur compounds termed "skunk," fair smelling reduced oil products for lubricating purposes, consisting in reducing the skunk bearing crude petroleum to a gravity of about 29° Baumé by evaporating the burning oil and other lighter portions at such temperatures and under such other conditions as to avoid the liberation of microscopic particles of carbon or other decomposition which would exclude the said residual product from the reduced oil class, and in subjecting the undistilled heavier portions of said skunk bearing petroleum in their natural state to oxidants which are without effect upon the hydrocarbons wherein the skunk is dissolved, so as to convert the skunk therein into inodorous oxidized compounds while preserving the lubricating quality of the said undistilled heavier portions of the crude petroleum, the addition of oxidant being before or after the evaporation of the said lighter portions.

649,048—May 8, 1900. HERMAN FRASCH. *Art of purifying petroleum.*

Claims the process of deodorizing oil of the Canadian or Lima class by the prolonged subjection of the skunk bearing oil to the action of an oxidating agent or agents in a closed vessel at a temperature above the distilling point of the said oil under atmospheric pressure and under a pressure of vapor in said vessel above the vapor tension of the oil at said temperature, so that the oil is retained in the liquid state during such subjecting, vaporization thereof being prevented by the excess of said pressure over the vapor tension of the said liquid oil.

655,500—August 7, 1900. THOMAS MACALPINE. *Process of refining mineral oils.*

Claims the process of refining petroleum and mineral oils, which consists in subjecting them to the action of a compound of acetylene and manganese.

658,857—October 2, 1900. THOMSON McGOWAN. *Process of desulphurizing petroleum oil.*

Claims the process of desulphurizing crude Lima or like sulphurized petroleum oil, which consists in distilling a mixture of sulphuric acid with said sulphurized oil which has not been previously treated so as to change the chemical character of the sulphur compounds therein.

660,449—January 22, 1901. JOHN W. WARREN. *Clarifying sulphurous hydrocarbon oils.*

Claims the method of clarifying sulphurous hydrocarbon oils, which consists in mixing with the oil disintegrated Wyoming rock clay, allowing the same to settle, and finally pouring off the oil.

683,354—September 24, 1901. FELIX C. THIELE. *Process of refining crude mineral oils and their distillates.*

Claims the process of refining crude mineral oils of the Lima type consisting in the addition of nitric acid thereto until sulphurous gases cease to be evolved; the conversion of the nitro and nitroso compounds into basic compounds by the addition of a nascent hydrogen producing substance until in a tested portion nitrous gases cease to be evolved in the presence of sulphuric acid, and the removal of the newly formed products by a subsequent acid treatment.

685,807—November 5, 1901. THEODORE F. COLIN. *Process of desulphurizing petroleum oils.*

Claims the process of desulphurizing petroleum of the Ohio class, which consists in mixing with the distillate concentrated sulphuric acid and some form of a metal, in a dry condition, which has a strong affinity for sulphur, and of which the sulphide is insoluble in the acid, so that the distillate will be subjected to the simultaneous action of the acid and said agent.

686,663—November 12, 1901. THOMAS MACALPINE. *Process of preparing an acetylene preparation of manganese.*

This invention consists in an improved process for preparing a special manganese compound which can be advantageously used in the purification of mineral oils; and,

Claims the process of preparing a manganese compound which consists in subjecting a solution or emulsion of compounds of the alkalies or alkaline earths to the action of acetylene gas and adding to the resulting product a solution containing manganese.

694,622—March 4, 1902. JESSE A. DUBBS. *Distilling oil.*

Claims as an improvement in the art of distilling oil, the method which consists in effecting vaporization of the oil by the combined action of heat and air forced through the oil, and in subjecting the vapor to a temperature higher than the vaporizing temperature of the oil.

705,168—July 22, 1902. JOHN W. WARREN. *Process of purifying hydrocarbon oils.*

Claims the method of clarifying hydrocarbon oils, which consists in treating the same with a solution of sugar of lead; absorbing the water and any foreign substances resulting from such latter operation by an addition of clay of Wyoming rock clay constitution; drawing off the distillate; treating it with sulphuric acid, neutralizing the same by an addition of said clay; drawing off the distillate; treating it with caustic potash; allowing it to stand; re-treating the distillate with said clay, and, finally, when clear, drawing off the distillate.

713,475—November 11, 1902. JOHN CARWILE MIMS. *Process of refining asphaltic mineral oils.*

Claims the process of removing asphaltum from mineral oils containing a high percentage of asphaltum which consists in adding to the oil a mixture of about 5 parts, by weight, of potassium bichromate to 95 parts of sulphuric acid in quantity equal to 1 to 10 per cent of the oil, allowing the asphaltum and associated impurities to settle, and then washing the oil with an aqueous solution containing about 5 per cent of sodium hydroxide and 5 per cent of sodium carbonate and then separating the purified oil from the sedimentary matter.

716,132—December 16, 1902. JOHN STEWART STEWART-WALLACE AND WILLIAM BLACKWELL COWELL. *Method of treating mineral oils or the distillates or residuals thereof.*

Claims a method of treating mineral oils consisting in placing them in a suitable vessel, supplying thereto caustic soda and permanganate of potash, heating and agitating the mixture, collecting and condensing any desired light oils that may be present in the mixture and driven off during such heating, allowing said mixture to settle in order that the impurities may separate therefrom, supplying the remaining mixture to the still and collecting the distillates.

723,868—March 24, 1903. THEODORE F. COLIN AND OTTO P. AMEND. *Process of purifying and desulphurizing crude petroleum and petroleum distillates.*

Claims the process of desulphurizing petroleum and its distillates which consists in the oxidation of the sulphur contained therein (without precipitation of the sulphur) by means of a hypochlorite in alkaline solution in the presence of an oxygen carrier or catalytic agent at ordinary or slightly elevated temperatures.

732,937—July 7, 1903. CHARLES BOOTHROY GRAHAM. *Process of refining oil.*

Claims the process of purifying oil, consisting in passing the same through a compound of lime water, pyrogallic acid, and caustic potash.

736,479—August 18, 1903. FRIEDRICH BERG. *Process of deodorizing or purifying petroleum.*

Claims an improvement in purifying or deodorizing petroleum, comprising the treatment of the oil with an alkali for several hours at a temperature considerably above 212° Fahrenheit in a closed chamber having an air outlet at the top, and condensing, within the upper end of said chamber next over the body of oil undergoing treatment, approximately all of the condensable vapors arising from the oil body and alkali during the said treatment and repeatedly converting the oil from a liquid to a vaporous or gaseous state and vice versa during the said treatment within the said upper end of the said chamber.

736,480—August 18, 1903. FRIEDRICH BERG. *Apparatus for deodorizing or purifying petroleum.*

Claims the combination, with a tank forming a vaporizing chamber having a top, a pipe extending upwardly from said top and communicating with the vapor space forming upper portion of the said chamber, and means for heating the said chamber, of two manifolds arranged within opposite sides of the said upper portion of the said chamber and extending circumferentially of the chamber near the aforesaid top, parallel pipe sections extending and establishing communication between the said manifolds and arranged a short distance apart laterally, means for conducting water into one of the said manifolds centrally between the ends of the respective manifold, means for conducting water from the other manifold centrally between the ends of the last-mentioned manifold, and means for supporting the said manifolds and the aforesaid pipe sections from the tank.

738,656—September 8, 1903. ARTHUR W. BURWELL AND LAYTON O. SHERMAN. *Process of desulphurizing crude petroleum.*

Claims the process of desulphurizing crude petroleum, which consists in distilling the petroleum, and passing the oil vapors in contact with oxides of iron and an alkaline earth metal, both of said oxides being entirely free from water.

744,730—November 24, 1903. THEODORE F. COLIN. *Process of desulphurizing sulphur-bearing petroleum.*

Claims the process of desulphurizing petroleum and its distillates which consists in treating them with an aqueous solution of iron sulphate, sodium chloride, and copper sulphate.

747,347—December 22, 1903. OTTO P. AMEND. *Process of desulphurizing oils or distillates.*

Claims the process of desulphurizing oil or distillate which consists in eliminating the sulphureted hydrogen contained therein; in neutralizing fatty and organic acids contained therein by subjecting them to the action of an alkali and then drawing off or removing the excess or settled alkali; in exposing the sulphur and sulphur compounds in the oil or distillate to the action of a soluble salt of copper in the presence of an alkali, but with the copper solution in excess of the alkali, thereby producing a hydrated copper in a neutral saline solution; in removing the excess of copper, the copper hydrosulphides, and residuum, and exposing the remaining copper and copper sulphides to the action of sulphuric acid, and in removing the acid and sludge.

747,348—December 22, 1903. OTTO P. AMEND. *Process of desulphurizing oils or distillates.*

Claims the process of desulphurizing oil or distillate which consists in eliminating sulphureted hydrogen therefrom by washing, blowing with steam or air or by both steam and air; in removing fatty and organic acids contained therein by subjecting them to the action of an alkali, in removing the alkali after agitation; in agitating the oil or distillate with a soluble salt of copper in the presence of a soluble carbonate; in removing the excess of copper salts and copper hydrosulphides thus formed and subjecting the oil or distillate to the action of sulphuric acid, then removing the acid sludge.

769,681—September 6, 1904. ALBERT C. CALKINS. *Process of treating oils.*

Claims the process or method of treating oil or other fluids which consists in confining the oil within a closed treating receptacle or tank, subjecting the oil to the action of sulphuric acid to precipitate tarry matters within the oil, withdrawing the sulphurous acid gas generated within the tank, and returning the same to and through the contents of the tank to bleach and agitate the oil.

783,916—February 28, 1905. GEORG VON WIRKNER. *Process of manufacturing pitch.*

Claims the process for obtaining pitch from tar oils and similar materials which consists in heating the same with a suitable quantity of sulphuric acid to a temperature of about 180° centigrade at least, until the sulphuric acid is decomposed and a sufficient quantity of the volatile bodies has been distilled off to leave a pitch of the desired consistency.

793,026—June 20, 1905. HENRY SPENCER BLACKMORE. *Process of separating sulphur from the sulphur containing constituents of petroleum and making hydrogen carbid.*

Claims the process of removing sulphur from petroleum containing the same, which consists in exposing sulphur containing petroleum to the action of an alkali earth metal carbid.

SUBCLASS 27.—INJECTING GASES.

10,055—September 27, 1853. WILLIAM BROWN. *Improvement in preparing paraffine oil.*

Claims the use of superheated steam in a special manner in the distillation of coal and other bituminous substances.

25,575—September 27, 1859. GEORGE M. MOWBRAY. *Improvement in processes of distilling oils from coal.*

Claims in the manufacture of coal oil and other pyrogenous oils by exposing the coal or other materials to the products of combustion generated in a separate furnace, igniting said products of combustion, previous to admitting the same into the distilling kiln, by admixture of a sufficient proportion of air to burn the oxide of carbon into carbonic acid.

27,767—April 10, 1860. LUTHER ATWOOD. *Improvement in the distillation of hydrocarbon oils.*

Claims the use of steam in preparing a hot still for the safe admission of a charge of oil.

28,448—May 29, 1860. LUTHER ATWOOD. *Improvement in the manufacture of oils obtained from coal.*

Claims the production of thin oils suitable to be manufactured into illuminating oils from the heavier parts of the crude and fixed oils and other substances within mentioned by treating them in manner substantially as hereinbefore described during one or several continuous distillations.

30,607—August 18, 1860. S. LLOYD WIEGAND. *Improvement in distilling oils and paraffine from peat and other substances.*

Claims the use of the products of the decomposition of steam by means of incandescent carbon in the separation of hydrocarbon oils and paraffine from peat or coal or other bituminous substances, whether used by themselves or in combination with superheated steam.

49,739—September 5, 1865. LEVI S. FALES. *Improved process of distilling petroleum.*

Claims the distillation of crude petroleum or other oils by heat applied above the surface through the medium of a current or currents of air circulating through the upper part of the still.

50,935—November 14, 1865; reissue 8,374—August 13, 1878. Division B. JAMES J. JOHNSTON. *Improvement in processes for evaporating liquids.*

Claims the process of obtaining a useful product from air, steam, and the vapor of hydrocarbon liquids, namely, by uniting them in a highly heated condition.

51,843—January 2, 1866. ORAZIO LUGO. *Improvement in distilling petroleum and other substances.*

This invention consists of an improvement in distillation by forcing into or through a still or stills a current of air or other suitable gaseous substance.

56,343—July 17, 1866. JAMES ADAIR AND H. W. C. TWEDDLE. *Improvement in evaporating and distilling liquids.*

Claims the mode of distilling or evaporating petroleum or other liquids by passing through or over the liquid to be distilled or evaporated heated carbonic oxide or carbonic acid.

58,113—September 18, 1866. ORAZIO LUGO. *Improvement in apparatus for distilling petroleum, etc.*

Claims the admission of air or gas into the goose neck or exit pipe of a still.

60,076—November 27, 1866. H. L. SMITH. *Improvement in treating oils, etc.*

Claims the process of treating crude petroleum, or its distillate, in a closed retort, by the introduction of steam.

60,396—December 11, 1866. ORAZIO LUGO AND T. O. L. SCHRADER. *Improved process of distilling petroleum oils and other substances.*

Claims the admission of air or gas into a still at a temperature equal to or greater than that of the oil or substance undergoing the distilling process.

86,535—February 2, 1869. CHARLES H. HALL. *Improvement in distilling hydrocarbon oils.*

Claims distilling hydrocarbon oils and other distillable liquids by steam, under pressure.

87,485—March 2, 1869. SAMUEL GIBBONS. *Improvement in the manufacture of lubricating oils from petroleum.*

Claims the preparing of petroleum or hydrocarbon oils for lubricating purposes, by reducing the gravity of the same by the direct action of steam or superheated steam upon the crude petroleum while in a still, tank, or retort.

87,638—March 9, 1869. SAMUEL GIBBONS. *Improved process of preparing petroleum to be used in lubricating wool.*

Claims an oil, or grease, made of petroleum, for the purpose of greasing wool.

99,975—February 15, 1870. HERBERT W. C. TWEDDLE. *Improvement in the manufacture of paraffine and paraffine oils.*

Claims the process of producing paraffine by an exhaustive distillation of the heavy oil at a comparatively low temperature by the use of steam in a vacuum still, with or without a fire heat, so as to drive over the paraffine vapors undecomposed.

100,874—March 15, 1870. JOSEPH B. EDWARDS. *Improvement in stills for distilling hydrocarbons.*

Claims the use of steam in the distillation of liquid hydrocarbons, in stills heated by external fire, when the steam is introduced into the still in such a manner that the lowest stratum of liquid therein will be continually removed from contact with the bottom of the still by the action of the steam, and its place supplied with fresh liquid from above.

120,349—October 24, 1871. HERBERT W. C. TWEDDLE. *Improvement in refining hydrocarbon oils.*

Claims the introduction of carbonic acid gas or other noninflammable gas into tanks or vessels containing petroleum, for the purpose of preventing the formation of explosive mixtures of hydrocarbon vapor and oxygen.

145,707—December 16, 1873. ASA W. WILKINSON. *Improvement in distilling petroleum.*

Claims the process of distilling petroleum, by injecting into and through the liquid mass contained in the still a gas or vapor which will not produce combustion, and will not enter into a deleterious combination with the product of distillation.

159,887—February 16, 1875. VICTOR G. BLOEDE. *Improvement in treating oils.*

Claims the process for reducing, distilling, or concentrating crude oils consisting of heating the oil from 212° to 500° Fahrenheit temperature, thoroughly agitating the same at such temperature, and injecting air or dry steam over the surface of the oil.

183,401—October 17, 1876. DANIEL M. LAMB. *Improvement in processes for refining petroleum and other oils.*

Claims in the art of treating oils by the agency of gas generated by the admixture of sodium chloride and sulphuric acid, the first step toward bleaching and deodorizing, which consists in generating the gas beneath the oil, and while the same is at rest, thus permitting the gas to permeate the oil and act upon the entire body.

184,275—August 14, 1877. REUBEN D. TURNER. *Improvement in processes and apparatus for cleaning and purifying oil, grease, etc.*

Claims the process for refining, purifying, and deodorizing oil, grease, or fatty matter by mingling the same with water, and violently agitating the liquid mass in a close vessel, a current or currents of air being forced into and through the liquids at the same time, and heat being applied during the first part of the operation.

212,914—March 4, 1879. HIRAM B. EVEREST. *Improvement in the distillation of oils.*

Claims the mode of preventing the scorching or burning of residual heavy oils in stills, which consists in injecting steam into the still after the distilling operation has been discontinued, and after the fires have been drawn, thereby cooling and agitating the residual oil by the steam simultaneously with the cooling of the surface of the still.

222,408—December 9, 1879. EDWARD C. KATTEL. *Improvement in refining petroleum oils.*

Claims the process of deodorizing an oleaginous substance, which consists in subjecting it to the action of superheated steam and atmospheric air introduced below the surface of the mass, the oleaginous substance being maintained at a temperature between 212° Fahrenheit and its point of vaporizing to prevent condensation of steam.

240,036—May 3, 1881. WILLIAM G. WARDEN. *Apparatus for and process of cooling and refining oil.*

Claims the process of cooling and refining oil, which consists in agitating it with a blast of air, which air has been previously cooled and dried by being passed successively, first, in contact with a cooled surface; second, through a bath of sulphuric acid; and, third, in contact with a cooled surface.

265,462—October 3, 1882. CHARLES J. TAGLIABUE. *Apparatus for and process of distilling petroleum.*

Claims the process of distilling petroleum, which consists, first, in heating the oil, then breaking up the same by successive operations of a steam atomizer, and of a jet or jets of hydrogen gas or hot air, mingling it with vapor which has not been submitted to the process of atomization, and condensing the mixed vapors.

306,965—October 21, 1884. MARVIN J. SEYMOUR. *Method of heating petroleum oil.*

Claims the method of precipitating water and other impurities in petroleum oil consisting, essentially, in heating natural gas by connecting one or more gas jets or burners with the gas supply pipe and arranging said burners in close proximity to said supply pipe, whereby the gas is heated, and then discharging the heated gas into the cold oil.

311,543—February 3, 1885. EBENEZER W. STRAIN. *Process of refining, reducing, and separating hydrocarbon oils.*

Claims the method of refining, reducing, and separating oil by a continuous process, consisting, first, in subjecting it to the action of heat under pressure and while in a state of transit, whereby it is raised to such a sufficient degree of temperature as to cause the separation of the volatile gases from the heavier oils on removal of the pressure; second, in spraying the heated oil in an expansion chamber, and, third, in trapping the oil which is condensed in the expansion chamber; and conveying the uncondensed vapors through surface condensers, where the vapors of different degrees of gravity are, at the points of condensation, trapped, and thereby separated.

339,545—April 6, 1886. JAMES B. GRANT. *Process of refining petroleum.*

Claims the process of refining petroleum and analogous oils, which consists in introducing the oil and steam together in an atomized condition into a heated chamber, and removing by means of a vacuum pump substantially the whole of the mixed vapor of oil and steam, without sensible condensation in the retort, into a condensing chamber.

372,672—November 8, 1887. THURSTON GORDON HALL. *Process of refining hydrocarbon oil.*

Claims the process of manufacturing hydrocarbon oil, which consists in subjecting the mingled vapors of a hydrocarbon oil and steam to large converting surfaces of granite or equivalent material heated to a temperature above 620° Fahrenheit by passing said vapors through and in contact with the converting material, and in subsequently condensing the same.

379,090—March 6, 1888. ROBERT J. WILSON. *Process of refining oil.*

Claims the process of refining crude oil and utilizing the waste products, which consists in subjecting said oil to the action of intensely heated air admitted directly to the body of the oil, thereby volatilizing the latter, then separating the greater portion of the volatilized oil from the air, and finally conducting off the air and uncondensed gases to be utilized for heating or illuminating purposes.

419,931—January 21, 1890. JAMES DEWAR AND BOVERTON REDWOOD. *Process of distilling mineral oils and like products.*

Claims the method of distilling mineral oils and like products, which consists in both vaporizing them and condensing the generated vapor under a regulated pressure of air or gas.

435,108—August 26, 1890. ROBERT ALEXANDER. *Process of refining crude asphaltum.*

Claims the process of refining crude asphaltum and obtaining an improved product therefrom, which consists in desiccating the crude asphaltum at a low temperature, recovering the condensable oils given off during desiccation, and subsequently returning said oils to the desiccated material.

444,202—January 6, 1891. ALLAN MASON. *Process of distilling oil.*

Claims the process of continuous fractional distillation of petroleum and other analogous oils in repeated steps of continuous succession and increased heat in which the previously unvaporized oil is successively treated, which consists of introducing the oil and steam together and causing the instantaneous junction of the same collectively in an atomized condition in the several heated chambers successively, instantaneously separating in the several chambers the portions vaporable by the respective temperatures, accelerating the movement of both the vaporized and unvaporized oil along the retort chambers to their respective exit passages by the impulse of the steam jets, exposing the vaporized portions all alike to the same conditions of time and heat in the respective chambers, similarly exposing all the unvaporized portions therein, and likewise and instantaneously removing both the vaporized and unvaporized portions to the condensers and successive sections of the retort, respectively, so that all portions of each have like exposure to the heat and steam in the respective chambers.

453,578—May 19, 1891. CHARLES C. MENGEL, SR. *Process of refining crude petroleum.*

Claims the process of refining Lima petroleum, which consists in introducing into the vapors arising from the still during the process of distillation natural gas in a heated condition equal to the temperature of the oil vapors, passing the mixture through pipes, boxes, or other suitable conduits of sufficient lengths, and superheated to prevent condensation, and allowing the necessary chemical action to take place, and finally conducting them into the condensers.

462,764—May 19, 1891. FREDERICK SALATHE. *Hydrocarbon product.*

Claims as a new manufacture, the hydrocarbon product, member of the C_nH_{15} series, the same being a solid material, with a specific gravity of about 1.028, tough and of a glossy jet black color, flexible and somewhat plastic at ordinary temperature, soluble in naphtha, turpentine, and other solvents before named, capable of withstanding a temperature of 600° Fahrenheit, resisting acids and alkalies, excepting concentrated nitric and concentrated sulphuric acids, and amalgamating with rubber.

470,911—March 15, 1892. JESSE A. DUBBS. *Desulphurizing oil.*

Claims the process of desulphurizing crude Lima and other mineral oils containing a large percentage of sulphur, which consists in forcing through the same before distillation a gas rich in hydrogen, whereby the sulphur in the oil will unite with the hydrogen of the gas passing off in the form of incondensable sulphureted hydrogen and preventing the formation of indestructible and deleterious carbon sulphides.

471,993—March 29, 1892. THOMAS DRAKE. *Process of refining oils.*

Claims the method of treating liquid mineral hydrocarbon, such as petroleum, which consists in first concentrating the oil, then forcing chlorine gas through it until its specific gravity has increased to between 0.900° and 1.05°, and finally correcting the acidity of the product.

486,406—November 15, 1892. JOHN B. HUSTON. *Process of removing sulphurous compound from oils.*

Claims the process of removing sulphurous compounds from oil, consisting of, first, vaporizing the oil; second, superheating the oil vapors conjointly with steam, free from the presence of oil or other liquid, to the temperature at which the sulphurous compounds are decomposed from the remaining portion of the oil vapors, so as to chemically unite with the hydrogen of the steam; third, separating the resultant vapors.

498,588—May 30, 1893. CHARLES TOPPAN. *Treating oils.*

Claims mineral or vegetable oils combined with the gases evolved from the admixture of chloride of sodium, metallic zinc, and sulphuric acid.

510,672—December 12, 1893. EDWARD G. BROWN, OSWALD N. CAMMANN, AND OLIVER WILLCOX. *Process of obtaining sweet residual petroleum products.*

Claims the continuous process of obtaining a refined and sweetened residual product of petroleum, consisting in, first, subjecting petroleum to distillation by the agency of heat externally applied; next, while still so heated causing the passage through it of saturated steam, and, finally, while still heated causing the passage through it of air.

524,180—August 7, 1894. FRANCIS X. BYERLEY. *Manufacture of asphalt, etc., from petroleum.*

Claims the process of making asphaltic products, by prolonged exposure of petroleum tar to a pitch forming noncoking temperature in a still, with agitation of said tar, and exposure of the same to air.

547,329—October 1, 1895. FRANCIS X. BYERLEY. *Process of refining Lima oil.*

Claims the process of obtaining purified distillates from Ohio or Lima oil, or, in other words, from oil containing the impurities which are characteristic of the petroleum from the vicinity of Lima, Ohio, and which resist removal by the sulphuric acid and alkali, or so-called Pennsylvania treatment, the said process consisting in distilling such oil at a low temperature with the aid of an exhaustion of the vapors, and during such distillation subjecting the said impurities to the action of air in volume sufficient to effect a substantial conversion thereof, as indicated by the loss of the characteristic malodor of the aforesaid oil.

554,341—July 21, 1896. FREDERICK SALATHE. *Hydrocarbon product.*

Claims the new composition of matter set forth, consisting of a conjugated oxy compound of bitumen and oxygen, having a melting point lying between 200° and 300° Fahrenheit, which has a higher specific gravity and a higher melting point and is less soluble in amylic alcohol and petroleum naphtha s and which, when melted, is more penetrating for saturating woody fiber than the bitumen from which it is formed and also than the corresponding sulphurized product, when in like condition and which under oxidation by concentrated nitric acid produces nitro products together with an organic acid identified with styphnic acid.

579,360—March 23, 1897. FRANK L. DYER. *Process of distilling volatile liquids.*

Claims in the art of distilling volatile liquids, the improvement which consists in maintaining the liquid to be distilled at a high vacuum, in injecting expanded and reheated steam into the liquid, whereby active distillation is effected and in maintaining the vacuum by the removal of the vaporized distillates as fast as formed.

664,818—December 25, 1900. THOMAS MACALPINE. *Process of distilling and refining oils.*

Claims the process of treating oils, which consists in heating said oils in a closed vessel, maintaining a partial vacuum in said vessel, and introducing into said vessel steam below 212° in temperature.

694,631—March 4, 1902. JESSE A. DUBBS. *Distilling oil.*

Claims as an improvement in the art of treating oils the method which consists in forcing air through the oil while the latter is maintained at a vaporizing temperature and then subjecting the distillate while heated to the action of air.

SUBCLASS 28.—RESIDUUM.

24,952—August 2, 1859. HENRY PEMBERTON. *Improvement in refining coal oils.*

Claims recovering the sulphuric acid used from the residuum resulting from the process of the purification of coal oils with sulphuric acid by treating the residuum with water heated or caused to boil by steam or otherwise.

32,705—July 2, 1861. JOSHUA MERRILL. *Improvement in the manufacture of hydrocarbon oils.*

Claims the improvement in the process of purifying hydrocarbon oils by treating the first distillate with acid residues.

37,918—March 17, 1863. ADOLPH MILLOCHAU. *Improvement in preparing a paint oil from the petroleum residuum.*

Claims the process of manufacturing oil adapted to mixing with paints and colors from the acid residuum in the refining of petroleum or coal oils.

38,641—May 19, 1863. ADOLPH MILLOCHAU. *Improved process of preparing oil as a substitute for linseed oil.*

This invention consists in combining the process of further distillation of the paint oil, either with or without the removal of the odor thereof, accompanied by the provision for allowing the liquid to settle properly with the washing the acid residuum and then treating it with alkali and permitting the product to settle after each of these operations.

41,085—January 5, 1864. ADOLPH MILLOCHAU. *Improvement in obtaining useful products from the tarry residuum of petroleum.*

Claims producing an oil grease from petroleum or coal oil tarry residuum by the process consisting in treating said residuum first with benzine or light oil, and then with an acid, and in removing the acid by means of an alkali and water.

59,581—November 6, 1866. MICHAEL BARRETT. *Improved process for the recovery and purification of sulphuric acid used in refining petroleum, etc.*

Claims the recovery, purification, and revivification of the sulphuric acid spent and deteriorated in the process of refining petroleum, coal, and shale oils by means of oxygen gas in the nascent state, by whatever means developed or obtained.

96,097—October 26, 1869. ALONZO FARRAR. *Improved process of obtaining useful oil from the acid residuum of petroleum.*

This consists in treating the residuum with caustic soda, lime, and water successively.

100,876—March 15, 1870. ALONZO FARRAR. *Improved process of treating acid residuum from oil refineries.*

This process involves a distillation of the lighter oils by heat, an incorporation of chlorine or chloride of lime with the residuum, and a subsequent heating and agitating of it until the desired effect results.

106,915—August 30, 1870. GERVAIS CHEVRIER. *Improvement in treating acid tars from coal.*

Claims the treatment of acid tars and oils with chloride of sodium or chloride of ammonium, whereby the residuum from distillation of coal oils may be purified and the acids utilized.

107,734—September 27, 1870. WILLIAM SPEARS. *Improvement in the manufacture of hydrocarbon oils.*

Claims an illuminating oil manufactured by distilling a chemical combination formed of benzine and tar.

110,364—December 20, 1870. CHRISTOPHER HOULKER. *Improvement in purifying oils which have been used in lubricating machinery.*

Claims the process for purifying or cleaning refuse petroleum lubricating oil that has been used for oiling shafting or other machinery.

178,061—May 30, 1876. WALTER P. JENNEY. *Improvement in obtaining a resinous substance from purified sludge oil.*

Claims the process for producing from sludge oil a substance or manufacture possessing the properties or qualities by combining the oxygen of the air with the sludge oil with the aid and assistance of a moderate degree of heat.

178,164—May 30, 1876. WALTER P. JENNEY. *Improvement in resinous substances.*

Claims the new manufacture or substance derived from sludge oil by a process of oxygenation, and possessing the substantial properties, among which are that it is a solid substance of greater or less consistency or hardness, has a resinous appearance, and is not acted upon by the specified alkalies.

189,402—April 10, 1877. HERBERT W. C. TWEDDLE. *Improvement in petroleum products and methods of obtaining the same.*

Claims the process for obtaining a new product from petroleum consisting in lixiviating the orange colored resinous oily product obtained toward the close of the distillation of tar residuum, and recovering the precipitate.

190,762—May 15, 1877. WALTER P. JENNEY. *Improvement in processes of treating sludge and sludge oil.*

Claims the process of manufacture for producing from sludge or sludge oil the substance possessing the properties or qualities described, by oxidizing the sludge oil by sulphuric acid.

230,171—July 20, 1880. HENRY BOWER. *Process of and apparatus for treating residuum from petroleum refineries.*

Claims the process of recovering sulphuric acid, oily ingredients suitable for redistillation, and solid carbon from the sludge acid residuum of petroleum refineries, which consists in subjecting the constituents of sludge acid to the successive operations of washing, mechanical separation, concentration, and distillation, and simultaneously condensing the waste vapors and discharging the products of condensation beneath the surface of running water.

488,628—December 27, 1892. HANS A. FRASCH. *Method or process of treating sludge.*

Claims the process of recovering and concentrating the sulphuric acid of sludge, which consists in leaching the sludge with water, the temperature of which is below the melting point of heavy sludge and the volatilizing point of light sludge, and then passing the watery product from one tank through the sludge of a series of tanks in succession, the accumulating solution being carried from tank to tank until the desired concentration or density of acid is obtained.

618,307—January 24, 1899. AUGUST WENDTLAND. *Process of removing green color from paraffine.*

Claims a process for removing the green color from petroleum residues which have been treated with sulphuric acid, which consists in treating the same with a soap composed of fatty acid and an alkaline solution, allowing the soapy and oily matters to separate, treating the oily portion with barium chloride solution, and filtering such oily portion through boneblack which has been impregnated with alcohol.

779,197—January 3, 1905. HORACE W. ASH. *Distillation and treatment of crude bituminous material.*

Claims the method of distilling and inspissating crude bituminous material comprising the subjection of the said material in a still to a distilling heat and depositing in the distilling material an impalpable powder.

779,198—January 3, 1905. HORACE W. ASH. *Method of distilling crude bituminous material.*

Claims the method of distilling and treating crude bituminous material consisting in subjecting the material in a still to the action of exterior heat upon the still and at the same time introducing into the still, under pressure, the products of combustion which have passed the exterior of the still.

SUBCLASS 29.—WASHING AND FILTERING.

36,488—September 16, 1862. JOHN TAGLIABUE. *Improved apparatus for testing the explosiveness of coal oils or petroleum.*

Claims the employment of holes in a water bath in connection with a mark for adjusting the height of the oil in the oil cup used for testing the flashing point.

36,836—October 28, 1862. G. TAGLIABUE. *Improvements in apparatus for testing the flashing and ignition point of oils.*

The claims cover a number of minor details which serve to increase the facility and accuracy in making the tests.

44,619—October 4, 1864. WILLIAM PORTER DOWNER. *Refining petroleum and other oils.*

Claims the use of a rotary hermetically-closed vessel for mixing petroleum and other oils with acids.

49,777—September 5, 1865. ADOLPH MILLOCHAU. *Improved instrument for testing petroleum.*

Claims an oil receptacle containing a wick tube or burner to heat and inflame the petroleum or other oil in combination with a thermometer introduced into such receptacle.

54,414—May 1, 1866. WILLIAM H. SANGSTER. *Improvement in apparatus for refining petroleum.*

This invention consists in placing a partition within the tank or vessel for holding the chemicals, which is so arranged as to separate it into two parts and leave an opening near the bottom, through which the oil is made to flow in its passage through the chemical solution from one division to the other, during the process of refining or washing; also, in combination therewith, of a perforated plate or its equivalent, for the purpose of increasing the distance of the flow of oil through the chemical solution.

57,285—August 21, 1866. D. H. BURKET AND J. C. GRAY. *Improved apparatus for treating petroleum.*

The object of this invention is to produce lubricating oil from petroleum in a crude state by means of simple mechanical combinations to agitate the oil, assisted by the introduction of steam or heated liquid into the oil while it is being agitated. By these means the gravity of the crude petroleum is reduced, which accomplishes the desired result.

60,585—December 18, 1866. HAMILTON L. SMITH. *Improvement in refining hydrocarbon.*

Claims a charcoal filter in combination with a receiver fan, heater, and coiled pipe.

61,125—January 8, 1867. P. H. VANDERWEYDE, M. D. *Improvement in refining petroleum and lubricating oils.*

Claims the heating of the heavy petroleum in a steam coil, thus preparing it for the filter, and in the same time saving and condensing the vapors arising, namely, gasoline, naphtha, and benzine.

62,708—March 12, 1867. W. H. YPUNG. *Improvement in preparing petroleum for lubricating.*

Claims the cleansing of oil by means of an underlying body of heated water.

63,051—March 19, 1867. FLEURY HUOT AND JOHN ROGERS. *Improvement in refining petroleum, &c.*

Claims separating the boneblack and impurities from the oil by filtering the same through a centrifugal filter.

63,051—March 19, 1867; reissue 3,145—October 6, 1868. FLEURY HUOT. *Improvement in refining petroleum.*

Claims the process set forth of purifying petroleum and other liquids by mixing with the same boneblack or other carbonaceous material, and then separating the said liquid from the carbonaceous substances by a centrifugal filter.

68,669—September 10, 1867. FORDYCE SYLVESTER. *Improvement in refining petroleum.*

Claims refining and purifying petroleum oil by passing it through hot water.

90,302—May 25, 1869. LUCIEN M. RICE AND SIDNEY E. ADAMS. *Improved apparatus for treating hydrocarbon oils.*

This invention consists in aerating and refining the fluid operated upon by projecting it upward in fine jets, and allowing it to fall in drops into a proper receptacle, by means of which the more volatile portion is separated, and passes off into the atmosphere, and a higher "fire test" is given to the oil and the machinery by which this is effected.

104,798—June 28, 1870. PETER H. VANDER WEYDE. *Improved instrument for testing oils.*

Claims the vaporizing of hydrocarbon oil or fluids in a transparent closed chamber, having its only vent sealed by water, in such manner that the vapors of such fluids will be isolated, and the temperature of "flashing point" shown.

109,772—November 29, 1870. WILLIAM M. SLOANE. *Improvement in purifying and refining oils.*

Claims the method of purifying oils by agitating with any deodorizing agent in a close vessel, under the action and pressure of steam.

110,638—January 3, 1871. RICHARD EATON. *Improvement in refining petroleum.*

Claims the art of removing earthy particles and other impurities from crude petroleum oil by the washing action of water.

133,598—December 3, 1872. EMIL SCHALK. *Improvement in treating petroleum.*

Claims a continuous process of treating and washing distilled petroleum.

154,430—August 25, 1874. REUBEN D. TURNER. *Improvement in apparatus for refining petroleum.*

This invention consists in the combination of a perforated steam coil with steam and oil atomizers arranged within a refining chamber, and connected with an outside oil heating vessel or tube, whereby all the obnoxious odors and explosive or "flashing" principles of the oil are absorbed and the oil generally improved for illuminating and other purposes.

174,021—March 21, 1876. CHARLES L. MOREHOUSE. *Improvement in processes and apparatus for manufacturing illuminating oils.*

Claims the process for refining hydrocarbon oils, consisting in treating them with steam, so as to remove the lighter portions, washing with caustic alkalies, and filtering with a warm filter.

297,603—April 29, 1884. JOHN B. HUSTON. *Apparatus for improving the fire test of petroleum and for bleaching other oils.*

This apparatus consists of a cylinder or vessel having a series of chambers, one above the other, the floors of which are perforated, with the exception of the lowest one. By the side of said vessel is placed a large air pipe having communications with the upper part of the said chambers. Within said pipe a steam pipe and an oil pipe are placed, the steam pipe having connections with the lower part of said chambers, while the oil pipe leads up to and communicates with a low chamber in the top of the aforesaid chambered vessel. The steam pipe warms the air in the air pipe and this warms the oil before they enter the said vessel. The branches of the steam pipe are provided with stopcocks. Outlet pipes are provided to each chamber, opposite to the steam and air pipes, for the escape of the vapors. This comprises the arrangement for treatment of petroleum products. For the bleaching purpose a box for containing the bleaching material is placed near the base of the said air pipe, to which it is connected by a short pipe. On opposite side of said box is placed an air blower for the purpose of forcing the fumes or gases from the said box into the aforesaid chambered vessel. From the top of the said vessel a pipe leads back to said blower. This is for returning the said bleaching gases to the blower and using them repeatedly.

299,611—June 3, 1884. LESLIE A. BAKER. *Process of refining petroleum.*

Claims a process of separating crude petroleum into its light and heavy constituents, consisting in mixing with the crude petroleum a cold medium, and thereby reducing its temperature, and then filtering the same.

313,514—March 10, 1885. JAMES W. NORTON AND FRANKLIN H. ROUSE. *Apparatus for removing paraffine from oil tanks.*

Claims the method of removing paraffine, sedimentary, or B. S. oil from the bottom of oil tanks, consisting, first, in forcing steam, hot air, or hot water through pipes to the bottom of the tank and beneath the oil in the same to liquefy the sedimentary deposits, and finally causing the withdrawal of the liquefied solution up through the said pipes and out from the tank to a suitable receptacle without removing the oil.

359,357—March 15, 1887. EDWARD D. KENDALL. *Process of and apparatus for refining hydrocarbon.*

Claims the process of treating distillate with sulphuric acid, which consists in forcing together regulated quantities of the acid and the distillate, and causing them to pass together under pressure through a pipe or tube provided with stationary obstructions, whereby they are thoroughly mingled by the force of the liquid itself.

363,432—May 24, 1887. LEVI STEVENS. *Process of distilling petroleum.*

Claims the process of vaporizing petroleum by injecting it into hot water heated above 212° Fahrenheit under pressure in a closed vessel, and conducting the vapors therefrom.

400,634—April 2, 1889. FRANCIS M. F. CAZIN. *Apparatus for refining petroleum.*

Claims the combination, with an upright vessel having a water supply pipe and an oil supply pipe leading to its lower part, of a water overflow pipe leading from a point between the ends of the vessel, first downward and thence upward to a point near the top of the vessel, thus forming a loop to permit the oil entering the pipe with the water to escape back to the vessel by reason of its lighter specific gravity, oil distributers arranged in the lower part of the vessel, whereby the entering oil is finely divided or diffused prior to rising through the water, and an oil overflow pipe at about the level of the water overflow.

405,047—June 11, 1889. THOMAS JEFFERSON NEWSOME. *Fluid separator.*

Claims a fluid separator consisting of a vessel or tank provided with a horizontal diaphragm forming an upper and lower chamber, a central tube communicating at its upper end with the upper chamber, its lower end extended within the lower chamber near the bottom thereof, a discharge pipe connected with the lower chamber above the lower end of the central tube, a discharge pipe connected with the lower portion of the upper chamber, and a funnel or tube adapted to enter the upper end of the central tube and projected therein to a point below the diaphragm.

618,728—November 8, 1898. MARTIN SHIVELY. *Method of and apparatus for purifying crude oils.*

Claims the method of purifying crude petroleum and other oils in bulk, consisting of delivering jets of hot water tangentially upon the surface of the oil contained in a tank or receptacle to cause the oil to rotate, then allowing the hot water to pass down through the rotating body of oil to simultaneously heat it and absorb and precipitate the impurities partly separated by the rotary movement of the oil.

672,882—April 30, 1901. CAL M. AUKERMAN. *Purifying system for crude petroleum.*

Claims in an oil purifying system, the combination with a receiving tank of a heating coil connected at one end to the lower portion of the tank by branch pipes, one branch tapping the tank below the normal water level, and another branch above the normal sediment level, the opposite end of the coil being connected with the top portion of the tank by a pipe having its opening within the tank below the normal oil level.

681,170—August 20, 1901. CHARLES R. HUDSON. *Clarifying apparatus.*

Claims in an apparatus for clarifying oil, an oil tank, a heater, a pipe extended from said heater over the oil tank, a column nozzle connecting with said pipe, a spray nozzle connecting with said pipe, and a pipe leading from the lower portion of the tank to the heater.

741,517—October 13, 1903. THOMAS MACALPINE. *Refining mineral oils.*

Claims in the process of refining mineral oil, whether crude oil or distillates thereof, the step which consists in subjecting said oil for a considerable time to the action of a solution composed of salt and carbonate of soda, said oil being kept in a state of subdivision during said time.

CLASS 73.—MEASURING INSTRUMENTS.

SUBCLASS 50.—FLUIDS.

35,184—May 6, 1862. HORACE J. SMITH AND WOODRUFF JONES. *Improvement in apparatus for testing coal oils and other mixed liquids.*

Claims determining the amount of volatile inflammable matter in compound liquids, by means of a thermometer and a flame, the thermometer being applied to the liquid while the heat is imparted to the latter, and the vapor generated by the heat being directed to the flame.

38,427—May 5, 1863. GIUSEPPE TAGLIABUE. *Improved instrument for ascertaining the amount of water, etc., in barrels of oil, etc.*

Claims a tube constructed of metal and glass with valves at top and bottom acted on by one rod, and opening and closing together, and a graduated scale on the glass sides of the tube.

56,107—July 3, 1866. GEORGE E. SHAW. *Improved carbon oil fire tester.*

Claims the water bath with a double casing and a pipe for the purpose of obtaining heat from the bottom only.

61,678—January 29, 1867. GEORGE E. SHAW. *Improved fire test torch.*

Claims the torch or lamp pivoted, suspended, or hinged to a clamp, or to a piece of a fire tester for carbon oil, so that it can be made to occupy either the vertical position or the horizontal position represented or any other position between the same.

91,843—June 29, 1869. HENRY M. HARTSHORN. *Improved instrument for testing the inflammability of illuminating oils.*

Claims a tight vessel, filled with water or other fluid, with a cavity or depression, holding the oil, forming the top of the vessel, and,

The combination of the stem of the thermometer with the tube, for the purpose of forming the handle.

127,259—May 28, 1872. PETHUEL MILLSPAUGH. *Improvement in testing burning fluids.*

Claims in combination with an instrument for testing oils or burning fluids a transparent cylinder or its equivalent for containing the fluid to be tested, and in which the thermometer is submerged.

139,654—June 10, 1873. JOHN B. BLAIR. *Improvement in apparatus for testing hydrocarbon oils.*

Claims a testing apparatus, consisting of a bottle with closed tube and a bottle with open tube in connection with a graduated support, all arranged, adapted, and operating as set forth.

152,855—July 7, 1874. STEPHEN S. MANN AND CHARLES B. MANN. *Improvement in devices for illustrating lamp explosions.*

Claims a device for illustrating lamp explosions, consisting of a cup or holder for attachment to the lamp bowl, and a detachable part that is held in the cup by means of frictional contact.

165,512—July 13, 1875. JOHN PONTON. *Improvement in automatic vapor tests for hydrocarbons.*

Claims the method or process of determining the relative temperatures at which hydrocarbons will vaporize, by conducting the vaporized hydrocarbon to the flame of a lamp, by which they are exploded, and indicating the temperature at the time of the explosion by a registering device.

197,197—November 13, 1877. FEARGUS B. SQUIRE. *Improvement in apparatus for testing the igniting temperature of hydrocarbon fluids.*

Claims in an apparatus for ascertaining the igniting temperature of hydrocarbon fluid, the combination of a fluid holding reservoir, a vertically adjustable flame holding device, and a thermometer graduated from the upper part of the bulb into equal spaces, independently of the thermometrical scale, to indicate the depth of its immersion in the said fluid, and for the purpose of adjusting the igniting flame to a required distance above the surface of the same.

204,235—May 28, 1878. STEPHEN S. MANN. *Improvement in devices for testing illuminating fluids.*

Claims in an oil testing apparatus, the combination, with an oil receiver, provided with a tube and a valve to be closed by pressure from within, of a projectile, made of any suitable material admitting of slight compression.

218,066—July 29, 1879. GEORGE M. SAYBOLT. *Improvement in electric oil testers.*

Claims in combination with the cup and reservoir of an oil fire tester, an electrical apparatus so arranged that an electrical spark from the apparatus flashes the vapor of the oil, whereby the fire test of the latter is determined.

221,421—November 11, 1879. THOMAS DE WITT PINCKNEY. *Improvement in kerosene oil testers.*

Claims a thermometrical device for ascertaining the flashing point of kerosene oil, which consists of a transparent graduated tube, provided with a bulb, having a cavity or recess in its upper part.

226,187—April 6, 1880. FRANCIS S. PEASE. *Apparatus for testing oil by electricity.*

Claims one or more electrical poles, having switches arranged on a movable and adjustable bridge, in combination with an oil bath of an oil testing apparatus.

240,365—April 19, 1881. ALEX BERNSTEIN. *Apparatus for testing illuminating fluids.*

Claims in an apparatus for testing the inflammability of oils, the combination, with an oil receptacle or vessel, provided with a fixed torch, a wick pipe beneath it, and a thermometer, of a hydrostatic tube, whereby the induced vapors are ejected at an ascertained temperature and ignited by the fixed torch and the ignition communicated to the wick.

245,508—August 9, 1881. GEORGE M. SAYBOLT. *Apparatus for testing hydrocarbon fluids.*

Claims an apparatus for testing hydrocarbon fluids or for finding their inflammable degree of temperature, consisting of a suitable bath, an oil vessel or cup, and a cap or cover for mechanically compressing the generated vapor at a certain point to eject it to an igniting torch.

309,718—December 23, 1884. CHARLES S. HIGGINS. *Apparatus for testing tallow, etc.*

Claims in an apparatus for testing tallow, the combination of the vessel having double walls and a space between them filled with nonconducting material, and provided with an inspection opening, and the double-walled cover, also filled with nonconducting material, with the glass receptacle for the tallow, placed inside the double-walled vessel.

431,795—July 8, 1890. FREELING W. ARVINE. *Apparatus for testing the burning qualities of oil.*

Claims the combination, in an instrument for testing the burning quality of oil, of a lamp-poising support, a marking point carried by said support, and a movable card holder.

774,341—November 8, 1904. FRANK N. SPELLER. *Recording calorimeter for gas.*

Claims in a device for measuring the heating value of gases, the combination of a combustion chamber, gas and air inlets thereto, means for maintaining constant pressure in said combustion chamber at all temperatures therein, and means for measuring the temperature in said chamber.

788,250—April 25, 1905. FERNAND A. COURTOIS. *Flash tester.*

Claims a flash tester comprising a support, a heater arranged underneath the support, a flue on the support, a test cup removably placed in the flue and having a trough around its upper portion, a burner tip for extending over the test cup, and a thermometer support.

POWER EMPLOYED IN MANUFACTURES

POWER EMPLOYED IN MANUFACTURES.[1]

By THOMAS COMMERFORD MARTIN, Expert Special Agent.

The total horsepower reported at the census of 1905 showed an increase of more than 40 per cent over that reported in 1900. The number of establishments reporting this power was less than 1 per cent greater than the number in 1900. This small increase is not wholly accounted for by the fact that the average horsepower per establishment has increased, but in part by the impossibility of eliminating from the statistics for 1900 all the power reported by the hand trades and neighborhood industries. The census of 1905 was one of factory industries only; that of 1900 was for factory industries and hand trades and neighborhood industries as well. It has not been practicable to separate from these latter industries any power except that of custom gristmills, custom sawmills, and cotton ginneries. But as a comparatively small amount of power is used in the other hand trades and neighborhood industries, the inclusion has little effect except upon the number of establishments reporting.

A comparative summary by kind and amount of power, for the censuses from 1870 to 1905, with percentages is as follows:

TABLE 1.—COMPARATIVE SUMMARY, WITH PER CENT OF INCREASE: 1870 TO 1905.

[For 1900 the number of establishments reporting power and the horsepower include the hand trades and neighborhood industries, except custom gristmills, custom sawmills, and cotton ginning. Prior to 1900 the total number of establishments, the number reporting power, and the horsepower include all hand trades and neighborhood industries.]

	CENSUS.					PER CENT OF INCREASE.			
	1905	1900	1890	1880	1870	1900 to 1905	1890 to 1900	1880 to 1890	1870 to 1880
Number of establishments	216,262	207,562	355,415	253,852	252,148	4.2	[1]41.6	40.0	0.7
Number of establishments reporting power	134,544	133,456	100,735	85,923	[2]	0.8	32.5	17.2	.....
Total horsepower	14,641,544	10,409,625	5,954,655	3,410,837	2,346,142	40.7	74.8	74.6	45.4
Average horsepower per establishment	108.8	78.0	59.1	39.7	[3]9.3	39.5	32.0	48.9	326.9
Owned—									
Engines—									
Steam—									
Number	127,425	130,754	91,410	56,483	[2]	[1]2.5	43.0	61.8	.....
Horsepower	10,828,111	8,140,533	4,581,595	2,185,458	1,215,711	33.0	77.7	109.6	79.8
Per cent of total horsepower	73.9	78.2	76.9	64.1	51.8	.....	.....	.....	.....
Gas and gasoline—									
Number	21,525	14,334	[2]	[2]	[2]	50.2	.....	.....	.....
Horsepower	289,514	134,742	8,930	[2]	[2]	114.9	1,408.9	.....	.....
Per cent of total horsepower	2.0	1.3	0.1	.....	.....	.....	.....	.....	.....
Water wheels[4]—									
Number	20,996	23,104	39,008	55,404	[2]	[1]9.1	[1]40.8	[1]29.6	.....
Horsepower	1,647,969	1,454,229	1,255,206	1,225,370	1,130,431	13.3	15.9	2.4	8.4
Per cent of total horsepower	11.3	14.0	21.1	35.9	48.2	.....	.....	.....	.....
Electric motors—									
Number	73,120	16,902	[2]	[2]	[2]	332.6	.....	.....	.....
Horsepower	1,150,891	310,661	15,569	[2]	[2]	270.5	1,895.4	.....	.....
Per cent of total horsepower	7.9	3.0	0.3	.....	.....	.....	.....	.....	.....
Other power, horsepower	92,154	49,985	4,784	[2]	[2]	84.4	944.8	.....	.....
Per cent of total horsepower	0.6	0.5	0.1	.....	.....	.....	.....	.....	.....
Rented, total	632,905	319,475	88,571	[2]	[2]	98.1	260.7	.....	.....
Per cent of total horsepower	4.3	3.0	1.5	.....	.....	.....	.....	.....	.....
Electric horsepower	441,592	182,562	[2]	[2]	[2]	141.9	.....	.....	.....
Other kind, horsepower	191,313	136,913	88,571	[2]	[2]	39.7	.....	.....	.....

[1] Decrease.
[2] Not reported.
[3] Average for all establishments enumerated, whether reporting or not reporting power.
[4] Includes 1,398 water motors with 5,934 horsepower for 1905.

The actual increase in the average horsepower per establishment was largest between 1900 and 1905. The 1870 average is not comparable with any other, as it is an average for all establishments whether reporting or not reporting power. Electric horsepower, although showing the largest percentage of increase, with gas and gasoline following, yields to steam in absolute increase. As at the censuses of 1890 and 1900, steam-power forms approximately three-fourths of the horsepower of all kinds reported, although electricity and

[1] Reference should be made to Tables 2, 12, 13, and 14 in Manufactures, Part I, 1905, for the detailed and comparative statistics concerning motive power, by states and territories, and by specified industries and groups of industries, and for industries showing 50,000 horsepower, and over, by states and territories and to various tables and the text relating thereto in Chapter X of the same volume.

gas and gasoline are continually reducing the proportion. Waterpower, while increasing absolutely, is diminishing in comparison with other kinds of power. When electric power is generated by the manufacturer the horsepower of the motors is a duplication, and allowance should be made for this fact in accepting the statistics.

In Table 1 the statistics of power for 11,474 establishments that were engaged in industries excluded from the census of 1905 are included for the census of 1900. These establishments used a total of 157,125 horsepower. Exclusive of rented power the steam horsepower reported in 1900, according to these revised figures, was 8,026,022; the water horsepower, 1,449,460; and the electric horsepower, 308,439—the increase in these particulars, as shown at the census for 1905, being 34.9, 13.7, and 273.1 per cent, respectively.

Consideration must also be given to the power reported by idle establishments. Table 2 compares the kind and amount of power in such establishments for the censuses of 1900 and 1905. In this table the totals for 1900 have been reduced by the exclusion, so far as possible, of the figures for establishments of the character omitted from the census of 1905.

TABLE 2.—*Power in idle establishments: 1905 and 1900.*

	1905	1900[1]
Number of establishments	2,330	3,149
Number of establishments reporting power	1,675	1,990
Total horsepower	344,671	203,774
Owned:		
Engines—		
Steam—		
Number	2,550	2,162
Horsepower	316,572	169,322
Gas and gasoline—		
Number	84	.....
Horsepower	1,941	.....
Water wheels—		
Number	309	524
Horsepower	17,093	30,495
Water motors—		
Number	5	[2]
Horsepower	39	[2]
Electric motors—		
Number	419	.....
Horsepower	8,776	.....
Other power, horsepower	250	3,957

[1] Exclusive of the hand trades and neighborhood industries, omitted from the census of 1905.
[2] Not reported separately.

Combining the power reported by idle establishments with that of active establishments shown in Table 1 gives an aggregate of 14,986,215 available horsepower for 1905, compared with 10,613,399 horsepower for 1900, or an increase of 41.2 per cent.

The totals given in Table 2 are not included in any tables of this report.

POWER IN SELECTED INDUSTRIES.

The power reported at the last four censuses for 11 selected industries and for all industries combined is shown in Table 3, which also gives the percentage that the different kinds of power form of the total employed in each of the several industries. These industries are not those reporting the largest amount of horsepower, but were selected as being typical of the factory method of manufacture.

It will be observed from Table 3 that the 11 selected industries absorbed slightly more than one-half of the total amount of horsepower reported for all industries at the census of 1905, namely, 7,795,780 horsepower, leaving 6,845,764 horsepower for the other industries of the country. In power consumption the manufacture of iron and steel is by far the most important of American industries, requiring not less than 2,722,508 horsepower, which, it may be incidentally noted, was very largely obtained from steam. All other sources of energy resorted to in this field are practically negligible, forming only 12.8 per cent of the total. These conditions are paralleled in the lumber and timber industry, which is next in importance as to power required, taking 1,504,693 horsepower, of which over 90 per cent is in steam.

The manufacture of paper and wood pulp is third in importance, requiring 1,122,564 horsepower, closely approached by cotton goods, employing 1,039,648 horsepower. The next largest branch of industry, when viewed with reference to power, is that which deals with flour and grist mill products, for which a total was returned of 780,042 horsepower.

No other of the industries shown in Table 3 reached anything like the same importance, although some of them have made remarkable strides in the last twenty-five years. Thus, for example, the total horsepower required for worsted goods in 1880 was only 16,437. At the census of 1905 it had become 130,620, an increase of almost sevenfold. In like manner the power required for hosiery and knit goods rose from 11,561 horsepower in 1880 to 83,814 horsepower at the census of 1905, this being an increase of over sixfold. These are industries in which the amount and value of products have increased greatly; and a further analysis establishing the relationship of the horsepower they consume to the kind and quantity of their products would be of interest as indicative of the greater refinement and increasing variety of American manufactures.

TABLE 3.—POWER, BY KIND, IN SELECTED INDUSTRIES, WITH PER CENT DISTRIBUTION OF TOTAL HORSEPOWER: 1880 TO 1905.[1]

[For 1900 the horsepower includes the hand trades and neighborhood industries, except custom gristmills, custom sawmills, and cotton ginning. Prior to 1900 the horsepower includes all hand trades and neighborhood industries.]

INDUSTRY.	1905							1900						
	Total horsepower.	Steam.		Water.		All other.		Total horsepower.	Steam.		Water.		All other.	
		Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.		Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.
All industries	14,041,544	10,828,111	73.9	1,647,969	11.3	2,165,464	14.8	10,409,625	8,140,533	78.2	1,454,229	14.0	814,863	7.8
Agricultural implements	106,623	75,018	70.4	6,300	5.9	25,305	23.7	77,189	61,147	79.2	6,758	8.8	9,284	12.0
Boots and shoes	62,587	40,228	64.3	1,612	2.6	20,747	33.1	50,623	34,666	68.5	2,240	4.4	13,717	27.1
Cotton goods[2]	1,039,648	707,607	68.1	252,923	24.3	79,118	7.6	811,347	531,611	65.5	255,875	31.5	23,861	3.0
Flour and grist mill products	780,042	473,689	60.7	258,352	33.1	48,001	6.2	672,084	407,475	60.6	242,821	36.1	21,788	3.3
Hosiery and knit goods	83,814	57,460	68.6	13,532	16.1	12,822	15.3	58,087	39,693	68.3	14,824	25.5	3,570	6.2
Iron and steel (blast furnaces, and steel works and rolling mills)	2,722,508	2,372,994	87.2	5,475	0.2	344,039	12.6	1,670,547	1,581,695	94.7	8,649	0.5	80,203	4.8
Lumber and timber products	1,504,693	1,377,722	91.6	103,677	6.9	23,294	1.5	1,383,002	1,226,091	88.7	146,500	10.6	10,411	0.7
Paper and wood pulp	1,122,564	370,852	33.0	717,989	64.0	33,723	3.0	764,847	255,854	33.4	504,762	66.0	4,231	0.6
Silk and silk goods	78,888	56,362	71.5	6,974	8.8	15,552	19.7	61,395	45,959	74.8	6,666	10.9	8,770	14.3
Woolen goods	163,793	96,940	59.2	55,931	34.1	10,922	6.7	139,645	82,933	59.4	52,358	37.5	4,354	3.1
Worsted goods	130,620	95,111	72.8	16,834	12.9	18,675	14.3	97,383	73,180	75.2	20,491	21.0	3,712	3.8
All other industries	6,845,764	5,104,128	74.6	208,370	3.0	1,533,266	22.4	4,623,476	3,800,229	82.2	192,285	4.2	630,962	13.6

INDUSTRY.	1890							1880				
	Total horsepower.	Steam.		Water.		All other.		Total horsepower.	Steam.		Water.	
		Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.		Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horse power.
All industries	5,954,655	4,662,029	78.3	1,263,343	21.2	29,283	0.5	3,410,837	2,185,458	64.1	1,225,379	35.9
Agricultural implements	50,395	40,673	80.7	9,667	19.2	55	0.1	44,731	32,086	71.7	12,645	28.3
Boots and shoes	30,686	27,885	90.9	1,874	6.1	927	3.0	11,574	11,164	96.5	410	3.5
Cotton goods	464,881	265,509	57.1	198,982	42.8	390	0.1	275,504	126,750	46.0	148,754	54.0
Flour and grist mill products	752,365	366,587	48.7	383,872	51.0	1,906	0.3	771,201	301,214	39.1	469,987	60.9
Hosiery and knit goods	34,538	22,005	63.7	12,360	35.8	173	0.5	11,561	6,069	52.5	5,492	47.5
Iron and steel (blast furnaces, and steel works and rolling mills)	745,824	737,771	98.9	8,053	1.1	.....	.....	397,247	380,741	95.8	16,506	4.2
Lumber and timber products	961,316	759,078	78.9	201,651	21.0	587	0.1	821,928	543,242	66.1	278,686	33.9
Paper and wood pulp	297,724	93,659	31.4	203,896	68.5	169	0.1	123,912	36,301	29.3	87,611	70.7
Silk and silk goods	29,638	24,427	82.4	4,864	16.4	347	1.2	8,810	7,248	82.3	1,562	17.7
Woolen goods	122,501	67,195	54.9	55,030	44.9	276	0.2	106,507	52,897	49.7	53,610	50.3
Worsted goods	57,111	44,458	77.8	12,437	21.8	216	0.4	16,437	10,135	61.7	6,302	38.3
All other industries	2,407,676	2,212,782	91.9	170,657	7.1	24,237	1.0	821,425	677,611	82.5	143,814	17.5

[1] For 1890 steam and water power represent owned and rented power. At subsequent censuses rented power was not segregated as to steam and water; the totals therefore represent owned power only.

[2] Includes cotton small wares.

The relative increase in power employed in the selected industries just referred to is brought out more clearly and fully in Table 4, which shows the power used in them from 1870 to 1905, with the amount and per cent of increase. This table shows also the kind of power used in each industry and its per cent of increase at each period.

TABLE 4.—POWER, BY KIND, IN SELECTED INDUSTRIES, WITH AMOUNT AND PER CENT OF INCREASE: 1870 TO 1905.[1]

[For 1900 the horsepower includes the hand trades and neighborhood industries, except *custom gristmills, custom sawmills,* and cotton ginning. Prior to 1900 the horsepower includes all hand trades and neighborhood industries.]

INDUSTRY.	TOTAL HORSEPOWER.					INCREASE.							
						1900 to 1905		1890 to 1900		1880 to 1890		1870 to 1880	
	1905	1900	1890	1880	1870	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
All industries	14,641,544	10,409,625	5,954,655	3,410,837	2,346,142	4,231,919	40.7	4,454,970	74.8	2,543,818	74.6	1,064,695	45.4
Agricultural implements	106,623	77,189	50,395	44,731	26,082	29,434	38.1	26,794	53.2	5,664	12.7	18,649	71.5
Boots and shoes	62,587	50,623	30,686	11,574	3,055	11,964	23.6	19,937	65.0	19,112	165.1	8,519	278.9
Cotton goods[2]	1,039,648	811,347	464,881	275,504	146,040	228,301	28.1	346,466	74.5	189,377	68.7	129,464	88.6
Flour and grist mill products	780,042	672,084	752,305	771,201	576,686	107,958	16.1	[3]80,281	[3]10.7	[3]18,836	[3]2.4	194,515	33.7
Hosiery and knit goods	83,814	58,087	34,538	11,561	6,498	25,727	44.3	23,549	68.2	22,977	198.8	5,063	77.9
Iron and steel (blast furnaces, and steel works and rolling mills)	2,722,508	1,670,547	745,824	397,247	170,675	1,051,961	63.0	924,723	124.0	348,577	87.7	226,572	132.8
Lumber and timber products	1,504,693	1,383,002	961,316	821,928	641,665	121,691	8.8	421,686	43.9	139,388	17.0	180,263	28.1
Paper and wood pulp	1,122,564	764,847	297,724	123,912	54,287	357,717	46.8	467,123	156.9	173,812	140.3	69,625	128.3
Silk and silk goods	78,888	61,395	29,638	8,810	1,911	17,493	28.5	31,757	107.1	20,828	236.4	6,899	361.0
Woolen goods	163,793	139,645	122,501	106,507	85,101	24,148	17.3	17,144	14.0	15,994	15.0	21,406	25.2
Worsted goods	130,620	97,383	57,111	16,437	8,016	33,237	34.1	40,272	70.5	40,674	247.5	8,421	105.1
All other industries	6,845,764	4,623,476	2,407,676	821,425	626,126	2,222,288	48.1	2,215,800	92.0	1,586,251	193.1	195,299	31.2

INDUSTRY.	STEAM.					INCREASE.							
						1900 to 1905		1890 to 1900		1880 to 1890		1870 to 1880	
	1905	1900	1890	1880	1870	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
All industries	10,828,111	8,140,533	4,662,029	2,185,458	1,215,711	2,687,578	33.0	3,478,504	74.6	2,476,571	113.3	969,747	79.8
Agricultural implements	75,018	61,147	40,673	32,086	15,873	13,871	22.7	20,474	50.3	8,587	26.8	16,213	102.1
Boots and shoes	40,228	34,666	27,885	11,164	2,892	5,562	16.0	6,781	24.3	16,721	149.8	8,272	286.0
Cotton goods	707,607	531,611	265,509	126,750	46,967	175,996	33.1	266,102	100.2	138,759	109.5	79,783	169.9
Flour and grist mill products	473,689	407,475	366,587	301,214	168,736	66,214	16.2	40,888	11.2	65,373	21.7	132,478	78.5
Hosiery and knit goods	57,460	39,693	22,005	6,069	2,223	17,767	44.8	17,688	80.4	15,936	262.6	3,846	173.0
Iron and steel (blast furnaces, and steel works and rolling mills)	2,372,994	1,581,695	737,771	380,741	154,091	791,299	50.0	843,924	114.4	357,030	93.8	226,650	147.1
Lumber and timber products	1,377,722	1,226,091	759,078	543,242	314,884	151,631	12.4	467,013	61.5	215,836	39.7	228,358	72.5
Paper and wood pulp	370,852	255,854	93,659	36,301	11,574	114,998	44.9	162,195	173.2	57,358	158.0	24,727	213.6
Silk and silk goods	56,362	45,959	24,427	7,248	1,122	10,403	22.6	21,532	88.1	17,179	237.0	6,126	546.0
Woolen goods	96,940	82,933	67,195	52,897	32,195	14,007	16.9	15,738	23.4	14,298	27.0	20,702	64.3
Worsted goods	95,111	73,180	44,458	10,135	3,382	21,931	30.0	28,722	64.6	34,323	338.7	6,753	199.7
All other industries	5,104,128	3,800,229	2,212,782	677,611	461,772	1,303,899	34.3	1,587,447	71.7	1,535,171	226.6	215,839	46.7

INDUSTRY.	WATER.					INCREASE.							
						1900 to 1905		1890 to 1900		1880 to 1890		1870 to 1880	
	1905	1900	1890	1880	1870	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
All industries	1,647,969	1,454,229	1,263,343	1,225,379	1,130,431	193,740	13.3	190,886	15.1	37,964	3.1	94,948	8.4
Agricultural implements	6,300	6,758	9,607	12,645	10,209	[3]458	[3]6.8	[3]2,909	[3]30.1	[3]2,978	[3]23.6	2,436	23.9
Boots and shoes	1,612	2,240	1,874	410	163	[3]628	[3]28.0	366	19.5	1,464	357.1	247	151.5
Cotton goods	252,923	255,875	198,982	148,754	99,073	[3]2,952	[3]1.2	56,893	28.6	50,228	33.8	49,681	50.1
Flour and grist mill products	258,352	242,821	383,872	469,987	407,950	15,531	6.4	[3]141,051	[3]36.7	[3]86,115	[3]18.3	62,037	15.2
Hosiery and knit goods	13,532	14,824	12,360	5,492	4,275	[3]1,292	[3]8.7	2,464	19.9	6,868	125.1	1,217	28.5
Iron and steel (blast furnaces, and steel works and rolling mills)	5,475	8,649	8,053	16,506	16,584	[3]3,174	[3]36.7	596	7.4	[3]8,453	[3]51.2	[3]78	[3]0.5
Lumber and timber products	103,677	146,500	201,651	278,686	326,781	[3]42,823	[3]29.2	[3]55,151	[3]27.3	[3]77,035	[3]27.6	[3]48,095	[3]14.7
Paper and wood pulp	717,989	504,762	203,896	87,611	42,713	213,227	42.2	300,866	147.6	116,285	132.7	44,898	105.1
Silk and silk goods	6,974	6,666	4,864	1,562	789	308	4.6	1,802	37.0	3,302	211.4	773	98.0
Woolen goods	55,931	52,358	55,039	53,610	52,906	3,573	6.8	[3]2,672	[3]4.9	1,420	2.6	704	1.3
Worsted goods	16,834	20,491	12,437	6,302	4,634	[3]3,657	[3]17.8	8,054	64.8	6,135	97.4	1,668	36.0
All other industries	208,370	192,285	170,657	143,814	164,354	16,085	8.4	21,628	12.7	26,843	18.7	[3]20,540	[3]12.5

[1] For 1890 steam and water power represent owned and rented power. At subsequent censuses rented power was not segregated as to steam and water; the totals therefore represent owned power only.

[2] Includes cotton small wares.

[3] Decrease.

TABLE 4.—POWER, BY KIND, IN SELECTED INDUSTRIES, WITH AMOUNT AND PER CENT OF INCREASE: 1870 TO 1905—Continued.

[For 1900 the horsepower includes the hand trades and neighborhood industries, except custom gristmills, custom sawmills, and cotton ginning. Prior to 1900 the horsepower includes all hand trades and neighborhood industries.]

INDUSTRY.	ALL OTHER.			INCREASE.			
	1905	1900	1890	1900 to 1905		1890 to 1900	
				Amount.	Per cent.	Amount.	Per cent.
All industries	2,165,464	814,863	29,283	1,350,601	165.7	785,580	2,682.7
Agricultural implements	25,305	9,284	55	16,021	172.6	9,229	16,780.0
Boots and shoes	20,747	13,717	927	7,030	51.3	12,790	1,379.7
Cotton goods	79,118	23,861	390	55,257	231.6	23,471	6,018.2
Flour and grist mill products	48,001	21,788	1,906	26,213	120.3	19,882	1,043.1
Hosiery and knit goods	12,822	3,570	173	9,252	259.2	3,397	1,963.6
Iron and steel (blast furnaces, and steel works and rolling mills)	344,039	80,203	.....	263,836	329.0	80,203	.....
Lumber and timber products	23,294	10,411	587	12,883	123.7	9,824	1,673.6
Paper and wood pulp	33,723	4,231	169	29,492	697.0	4,062	2,403.6
Silk and silk goods	15,552	8,770	347	6,782	77.3	8,423	2,427.4
Woolen goods	10,922	4,354	276	6,568	150.8	4,078	1,477.5
Worsted goods	18,675	3,712	216	14,963	403.1	3,496	1,618.5
All other industries	1,533,266	630,962	24,237	902,304	143.0	606,725	2,503.3

It will be observed that since 1870 the relative position of the selected industries has varied in rather a remarkable manner. For example, in 1870 the iron and steel industry was third on the list, with only 170,675 horsepower, being exceeded by the lumber and the flour and grist mill industries, each of which employed considerably over half a million horsepower. It held the same rank in 1880 and in 1890, although by that time it had risen almost to an equality with flour and grist mills. The next decade, however, witnessed enormous strides, and saw it rise to the first rank. At the census of 1905 its preeminence was so marked that its horsepower was actually larger than that of the flour and grist and lumber and timber industries combined, being 2,722,508 horsepower, as compared with 2,284,735 of the two industries. This is perhaps the most striking change observable in the whole group of selected industries.

A further instance of remarkable growth, but of a more steady character, is seen in the cotton industry, in which in 1870 only 146,040 horsepower was employed. This increased in the decade 1870 to 1880 by 129,464, or 88.6 per cent, and in the next ten years 68.7 per cent. In 1900 the per cent of increase was 74.5 and the total horsepower reported was 811,347. While this rate has not been maintained, which could hardly have been expected, the amount reported for the census period ending with 1905 was not less than 1,039,648 horsepower, placing the production of cotton goods in the fourth rank as to power plant.

The greatest decline in percentages of increase, although the amount of power consumed is not large, are those exhibited by silk and silk goods, in which industry the amount of power required rose from 1,911 horsepower in 1870 to 78,888 horsepower at the census of 1905. While the absolute increase in power required in the industry is notable, the per cent of increase has naturally fallen off.

Some very singular changes are brought to notice by the figures relating to the increase in the kind of power, but statements and inferences with regard to them must be presented with caution, chiefly because of the introduction of electric power into every branch of manufacture. This form of energy is not in itself a prime mover, but is a means of transmission and distribution, standing between the original steam, water, or even gas power, and the consumption apparatus to which the transformed and transmitted energy is delivered. Hence, as will be seen, the percentages of increase for "all other power," in which electric power is included, are far in excess of those reported for steam and water. The increase for "all other power" in the period 1900 to 1905 was 165.7 per cent, although this is small compared with the extraordinary increase of nearly twenty-seven fold in the census period 1890 to 1900. In some of the selected industries, also, the increased use of "all other power" between 1900 and 1905 was striking, being 697 per cent in the paper and wood pulp industry. This is wholly attributable to the increased use of electric power.

Table 5 shows the total horsepower employed in the 11 selected industries, with the percentage of increase, the power installed per wage-earner, and the power per $1,000 of products, from 1870 to 1905.

TABLE 5.—POWER IN SELECTED INDUSTRIES, WITH PER CENT OF INCREASE; HORSEPOWER PER WAGE-EARNER; AND HORSEPOWER PER $1,000 OF PRODUCTS: 1870 TO 1905.

INDUSTRY.	Census.	Horsepower.	Per cent of increase in horsepower.	Average number of wage-earners.	Horsepower per wage-earner.	Value of products.	Horsepower per $1,000 of products.
Agricultural implements	1905	106,623	38.1	47,994	2.2	$112,007,344	1.0
	1900	77,189	53.2	46,582	1.7	101,207,428	0.8
	1890	50,395	12.7	38,827	1.3	81,271,651	0.6
	1880	44,731	71.5	39,580	1.1	68,640,486	0.7
	1870	26,082	.....	25,249	1.0	52,066,875	0.5
Boots and shoes	1905	62,587	23.6	149,924	0.4	320,107,458	2.0
	1900	50,623	65.0	141,830	0.4	258,969,580	0.2
	1890	30,686	165.1	133,690	0.2	220,649,358	0.1
	1880	11,574	278.9	111,152	0.1	166,050,354	0.1
	1870	3,055	.....	91,702	(1)	146,704,055	(1)
Cotton goods [2]	1905	1,039,648	28.1	315,874	3.3	450,407,704	2.3
	1900	811,347	74.5	302,861	2.7	339,200,320	2.4
	1890	464,881	68.7	218,876	2.1	267,981,724	1.7
	1880	275,504	88.6	185,472	1.5	210,950,383	1.3
	1870	146,040	.....	135,519	1.1	177,489,739	0.8
Flour and grist mill products	1905	[3] 780,042	16.1	39,110	19.9	713,033,395	1.1
	1900	672,084	[4] 10.7	32,226	20.9	501,396,304	1.3
	1890	752,365	[4] 2.4	47,403	15.9	513,971,474	1.5
	1880	771,201	33.7	58,407	13.2	505,185,712	1.5
	1870	576,686	.....	58,448	9.9	444,985,143	1.3
Hosiery and knit goods	1905	83,814	44.3	103,715	0.8	136,558,139	0.6
	1900	58,087	68.2	83,387	0.7	95,482,566	0.6
	1890	34,538	198.8	59,588	0.6	67,241,013	0.5
	1880	11,561	77.9	28,885	0.4	29,167,227	0.4
	1870	6,498	.....	14,788	0.4	18,411,564	0.4
Iron and steel (blast furnaces, and steel works and rolling mills)	1905	2,722,508	63.0	242,640	11.2	905,787,733	3.0
	1900	1,670,547	124.0	222,490	7.5	803,968,273	2.1
	1890	745,824	87.7	148,715	5.0	478,687,519	1.6
	1880	397,247	132.8	140,978	2.8	296,557,685	1.3
	1870	170,675	.....	77,555	2.2	307,208,696	0.6
Lumber and timber products	1905	[3] 1,504,693	8.8	404,626	3.7	580,022,690	2.6
	1900	1,383,002	43.9	413,335	3.3	555,197,271	2.5
	1890	961,316	17.0	311,964	3.1	437,957,382	2.2
	1880	821,928	28.1	147,956	5.6	233,268,729	3.5
	1870	641,665	.....	149,097	4.3	210,159,327	3.1
Paper and wood pulp	1905	1,122,564	46.8	65,964	17.0	188,715,189	5.9
	1900	764,847	156.9	49,646	15.4	127,326,162	6.0
	1890	297,724	140.3	31,050	9.6	78,937,184	3.8
	1880	[5] 123,912	128.3	25,631	4.8	55,109,014	2.2
	1870	54,287	.....	18,021	3.0	50,842,445	1.1
Silk and silk goods	1905	78,888	28.5	79,601	1.0	133,288,072	0.6
	1900	61,395	107.1	65,416	0.9	107,256,258	0.6
	1890	29,638	236.4	49,382	0.6	87,298,454	0.3
	1880	8,810	361.0	31,337	0.3	41,033,045	0.2
	1870	1,911	.....	6,699	0.3	12,210,662	0.2
Woolen goods	1905	163,793	17.3	72,747	2.3	142,196,658	1.2
	1900	139,645	14.0	68,893	2.0	118,430,158	1.2
	1890	122,501	15.0	76,915	1.6	133,577,977	0.9
	1880	106,507	25.2	86,504	1.2	160,606,721	0.7
	1870	85,101	.....	77,870	1.1	155,405,358	0.5
Worsted goods	1905	130,620	34.1	69,251	1.9	165,745,052	0.8
	1900	97,383	70.5	57,008	1.7	120,314,344	0.8
	1890	57,111	247.5	42,978	1.3	79,194,652	0.7
	1880	16,437	105.1	18,803	0.9	33,549,942	0.5
	1870	8,016	.....	12,920	0.6	22,090,331	0.4

[1] Less than one-tenth of 1 horsepower.
[2] Includes cotton small wares.
[3] Exclusive of custom mills.
[4] Decrease.
[5] Horsepower exclusive of "wood pulp," for which figures were not accessible.

These figures as a whole may be taken to represent the further transition from hand labor to power driven machinery, as there has been a steady rise in all but 2 of the 11 industries in the average amount of power utilized per wage-earner. It will be seen from this table that the amount of horsepower per wage-earner in the production of agricultural implements has risen in the thirty-five years from 1 horsepower to 2.2. In like manner the value of products and the horsepower per $1,000 of products have doubled. But the power per wage-earner in the lumber and timber industry has fallen off. In 1870 the average power per wage-earner was 4.3, but at the census of 1905 it was only 3.7, and the horsepower per $1,000 of products, which in 1870 was 3.1, had declined to 2.6. In the paper and wood pulp industry, to some extent allied to that of lumber and timber, the power per wage-earner in 1870 was 3, but it was 17 at the census of 1905, almost a fivefold increase. The horsepower per $1,000 of products had risen from 1.1 to 5.9. The iron and steel industry since 1870 shows an increase in horsepower per wage-earner from 2.2 to 11.2, while the horsepower per $1,000 of products had risen from six-tenths of 1 to 3. During this period the boot and shoe industry underwent a remarkable process of development and transition from handicraft to machine production. In 1880 the

average horsepower per wage-earner was one-tenth of 1, but it had risen by 1905 to four-tenths of 1. During the same period the horsepower per $1,000 of products had increased from one-tenth of 1 to 2. No statistics are available to show the actual production of shoes in the country by handpower, but these figures contain an indication of the extent to which the power-made shoe has supplanted that which was made in the old hand shop where every customer had an individual last.

A very remarkable increase is exhibited in the industry of silk and silk goods. The power per wage-earner increased from three-tenths of 1 in 1870 to 1 at the census of 1905, and the horsepower per $1,000 of products from two-tenths of 1 to six-tenths of 1, a two-fold increase. During the same period the products increased approximately from $12,000,000 to over $133,000,000, or about tenfold.

Between the industries of silk and silk goods and paper and wood pulp there is an extraordinary contrast at the census of 1905. The average per wage-earner in the paper and wood pulp industry, 17 horsepower, compares with 1 horsepower in the silk industry and 5.9 horsepower per $1,000 of products compares with six-tenths of 1. The total value of the paper and wood pulp products is $188,715,189, as compared with $133,288,072 of silk and silk goods. Such a result naturally arises from the great difference in the character of the materials, and is also due to the fact that labor has been supplanted largely by machinery in the production of widely different products.

This condition is signally exemplified also by the products of worsted goods. It is somewhat surprising to find that for 1905 these fall only $20,000,000 short in value of the paper and wood pulp industry. The power capacity per wage-earner in the worsted industry is only 1.9, and the horsepower per $1,000 of products is only eight-tenths of 1.

GEOGRAPHIC DISTRIBUTION OF POWER.

In Table 6 is given the total horsepower and percentage of steam, water, and other power, distributed by geographic divisions, from 1870 to 1905.

TABLE 6.—POWER, BY KIND, WITH PER CENT DISTRIBUTION OF TOTAL HORSEPOWER, BY GEOGRAPHIC DIVISIONS: 1870 TO 1905.[1]

[For 1900 the horsepower includes the hand trades and neighborhood industries, except custom gristmills, custom sawmills, and cotton ginning. Prior to 1900 the horsepower includes all hand trades and neighborhood industries.]

DIVISION.	1905							1900						
	Total horsepower.	Steam.		Water.		All other.		Total horsepower.	Steam.		Water.		All other.	
		Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.		Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.
United States...	14,641,544	10,828,111	73.9	1,647,969	11.3	2,165,464	14.8	10,409,625	8,140,533	78.2	1,454,229	14.0	814,863	7.8
New England states..	2,254,264	1,335,547	59.3	659,071	29.2	259,646	11.5	1,826,680	1,093,431	59.9	619,209	33.9	114,040	6.2
Middle states.....	5,000,367	3,520,680	70.4	531,718	10.6	947,969	19.0	3,453,468	2,685,832	77.8	426,356	12.3	341,280	9.9
Southern states.....	2,386,330	2,085,160	87.4	147,680	6.2	153,490	6.4	1,601,184	1,410,956	88.1	136,514	8.5	53,714	3.4
Central states.....	4,077,298	3,185,875	78.1	243,374	6.0	648,049	15.9	2,984,781	2,528,911	84.7	206,437	6.9	249,433	8.4
Western states.....	445,937	339,084	76.0	33,475	7.5	73,378	16.5	260,435	199,524	76.6	34,800	13.4	26,111	10.0
Pacific states.....	474,397	359,002	75.7	32,562	6.9	82,833	17.4	281,719	220,925	78.4	30,796	10.9	29,998	10.7
Outlying districts....	2,951	2,763	93.6	89	3.0	99	3.4	1,358	954	70.3	117	8.6	287	21.1

DIVISION.	1890							1880					1870				
	Total horsepower.	Steam.		Water.		All other.		Total horsepower.	Steam.		Water.		Total horsepower.	Steam.		Water.	
		Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.		Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.		Horsepower.	Per cent of total horsepower.	Horsepower.	Per cent of total horsepower.
United States...	5,954,655	4,662,029	78.3	1,263,343	21.2	29,283	0.5	3,410,837	2,185,458	64.1	1,225,379	35.9	2,346,142	1,215,711	51.8	1,130,431	48.2
New England states..	1,159,971	654,039	56.4	501,629	43.2	4,303	0.4	743,106	320,201	43.1	422,905	56.9	514,730	152,704	29.7	362,026	70.3
Middle states.....	2,055,645	1,690,144	82.2	355,088	17.3	10,413	0.5	1,136,239	755,841	66.5	380,398	33.5	799,264	399,413	50.0	399,851	50.0
Southern states.....	799,404	632,652	79.1	163,803	20.5	2,949	0.4	434,876	265,572	61.1	169,304	38.9	321,498	161,415	50.2	160,083	49.8
Central states.....	1,667,434	1,457,045	87.4	200,941	12.0	9,448	0.6	996,883	782,022	78.4	214,861	21.6	645,558	461,785	71.5	183,773	28.5
Western states.....	123,239	100,027	81.2	22,279	18.1	933	0.7	48,828	26,207	53.7	22,621	46.3	28,622	18,019	63.0	10,603	37.0
Pacific states.....	148,511	127,832	86.1	19,442	13.1	1,237	0.8	50,905	35,615	70.0	15,290	30.0	36,470	22,375	61.3	14,095	38.7
Outlying districts....	451	290	64.3	161	35.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

[1] For 1890 steam and water power represent owned and rented power. At subsequent censuses rented power was not segregated as to steam and water; the totals therefore represent owned power only.

Table 6 is one of the most interesting in this report, exhibiting, as it does, the development of manufactures in sections of the country which had previously played a minor part in strictly industrial development. Of the total (14,641,544) horsepower, by far the larger part, no less than 9,077,665 horsepower, is shown to be in use in the Middle and Central states. Another significant fact is that for the first time in the history

of the country the horsepower employed in manufactures in the Southern states exceeds that reported for the New England states. At the census of 1870 the Southern states reported 321,498 horsepower, and the New England states, 514,730 horsepower. At the census of 1905 the Southern states reported 2,386,330 horsepower, exceeding that reported for New England by 132,066 horsepower. In this connection it is also interesting to note that the development in the Southern states has been largely due to the utilization of steampower, this being 87.4 per cent of the total at the census of 1905, and the waterpower being only 6.2 per cent, whereas in New England the percentage of waterpower was 29.2 and of steampower 59.3.

As far back as 1870 both the Middle and Central state groups had horsepower in manufactures in excess of New England. At the census of 1905 the Southern states reported 40,188 horsepower in excess of the total horsepower employed in manufactures in the whole country thirty-five years earlier. Curiously enough, however, the proportion of power developed in the Southern states has remained roughly about one-seventh of the whole throughout the entire period.

In 1870 there was very little manufacturing development in any of the Pacific or far Western states, so that in that year the total for these two geographic divisions was only 65,092 horsepower. It will be understood, however, that these figures do not include mining operations, in which even at that period the development west of the Missouri was very large. The actual increase in the next decade was comparatively small, but since 1890 the growth has been rapid, so that, as will be seen, at the census of 1905 the Pacific states reported 474,397 horsepower and the Western states 445,937 horsepower. To a striking extent also, as will be noted, steampower has preponderated throughout the entire period. At the last census period the percentage of steampower in these sections was, for the Pacific states, 75.7, and for the Western, 76; while waterpower had fallen from 38.7 and 37 per cent, respectively, in 1870 to as low as 6.9 and 7.5 per cent at the census of 1905, subject to the corrections for "all other power" due to the influence of electrical transmission.

STEAMPOWER.

Table 7 presents the statistics as to the amount of steampower used in the states and territories at the censuses of 1870 to 1905, inclusive, with the amount and per cent of increase.

The fact has already been brought out that throughout the entire period steam has been the dominant primary power, and the census returns show that it has rapidly risen in relative importance—from 51.8 per cent of the whole in 1870 to 73.9 per cent for 1905. In other words, out of a total of 14,641,544 horsepower reported for 1905, steam contributed 10,828,111 horsepower. American industry as it develops tends more and more to the application of power to products of smaller bulk and a higher value of finished article. At the same time, with the increasing amount of steam used, the cost of steampower becomes less, owing to the great increase in the size of the units employed. In this connection it is noticeable that there were actually fewer steam engines in use as reported at the census of 1905 than in 1900, but, on the other hand, the average size of the units had risen from 39 horsepower in 1880 to 50 horsepower in 1890, 62 in 1900, and 85 at the census of 1905. As a matter of fact, however, these statistics are confused or vitiated by the fact that while the average steam engine to-day in a new mill or factory is of several hundred horsepower, steam has been increasingly used as a means of operating the auxiliary apparatus, such as pumps, stokers, blowers, conveyers, etc., although here also the electric motor has found increasing use.

The effect of a "heavy" industry on the utilization of steampower is strikingly illustrated in Table 7, from which it will be seen that Pennsylvania, the principal center of the iron and steel industry, is credited with 2,088,773 steam horsepower, or almost 20 per cent of the total for the whole country. In like manner, the large amount of 1,028,665 horsepower is reported for Ohio, so that these two states have nearly 30 per cent of the entire steampower employed in all manufactures, as the result largely of the use of motive power in the metal industries. In point of importance New York comes third with 850,497 horsepower, followed by Massachusetts, with 690,467 horsepower, and Illinois, with 651,578.

The percentage of increase in these states from 1900 to 1905 was 31.6 for Pennsylvania, 40.5 for Ohio, 28.9 for New York, 19.8 for Massachusetts, and 28.4 for Illinois. As might be expected, the largest percentage of increase was shown in some of the Western states and territories, such as Alaska, with 189.6 per cent; Arizona, 146 per cent; Colorado, 198.3 per cent; Idaho, 277.7 per cent; Indian Territory, 139.5 per cent; Oklahoma, 155.7 per cent; and Washington, 93.3 per cent.

The Southern states, however, were conspicuous for large increases. In Alabama the increase was from 162,453 horsepower to 280,470, a percentage of increase in the five years of 72.6. In Georgia the horsepower rose from 110,972 to 183,369, an increase of 65.2 per cent. In Mississippi the gain was from 64,731 horsepower to 109,418, an increase in the census period of 69 per cent. In North Carolina the percentage of increase was 49.2, namely, from 122,778 horsepower to 183,166. South Carolina, however, exceeded in gains all other Southern states, nearly doubling its horsepower, namely, from 80,913 to 157,432 horsepower, an increase of not less than 94.6 per cent. As will be observed from the table, these increases in the South are in line with those which were shown during the period from 1890 to 1900, although these states do not maintain the very large propor-

tionate gains which were shown prior to 1890, when the amounts dealt with were so small that an insignificant gain involved a relatively large percentage of increase. It is to be observed with regard to the Southern states that the gains were well distributed, although occurring chiefly in the regions enjoying the most rapid development of textile industries, mineral, and timber resources for manufacturing purposes.

In a preceding paragraph reference has been made to the average size of all engines employed, as well as the general effect of a "heavy" industry on the utilization of steampower. Data as to both conditions and their relationship, which are interesting in this connection, are to be found in Table 14 of the Report on Manufactures, Part I, showing the motive power for industries employing 50,000 horsepower and over at the census of 1905. Thus in the iron and steel blast furnaces the total for the United States was 1,555 engines of 762,382 horsepower, giving an average of 490 horsepower per engine. In Pennsylvania, with 582 engines and 298,567 horsepower, the average per engine was 513 horsepower. Both Ohio and Alabama showed a higher average than Pennsylvania, the 280 blast furnace engines in Ohio having an average of 599 horsepower, while the 163 engines employed in Alabama had an average of 615 horsepower per engine.

TABLE 7.—STEAMPOWER, WITH AMOUNT AND PER CENT OF INCREASE, BY STATES AND TERRITORIES: 1870 TO 1905.

[For 1900 the horsepower includes the hand trades and neighborhood industries, except custom gristmills, custom sawmills, and cotton ginning. Prior to 1900 the horsepower includes all hand trades and neighborhood industries.]

STATE OR TERRITORY.	HORSEPOWER.[1]					INCREASE.							
						1900 to 1905		1890 to 1900		1880 to 1890		1870 to 1880	
	1905	1900	1890	1880	1870	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
United States	10,828,111	8,140,533	4,662,029	2,185,458	1,215,711	2,687,578	33.0	3,478,504	74.6	2,476,571	113.3	969,747	79.8
Alabama	280,470	162,453	91,805	15,779	7,740	118,017	72.6	70,648	77.0	76,026	481.8	8,039	103.9
Alaska	2,763	954	290	.....	.....	1,809	189.6	664	229.0	290	.....	.....	.....
Arizona	18,828	7,653	497	370	80	11,175	146.0	7,156	1,439.8	127	34.3	290	362.5
Arkansas	107,699	78,016	36,525	13,709	6,101	29,683	38.0	41,491	113.6	22,816	166.4	7,608	124.7
California	153,178	105,190	67,426	28,071	18,493	47,988	45.6	37,764	56.0	39,355	140.2	9,578	51.8
Colorado	117,539	39,400	30,900	3,953	1,433	78,139	198.3	8,500	27.5	26,947	681.7	2,520	175.9
Connecticut	218,668	177,819	98,038	57,027	25,979	40,849	23.0	79,781	81.4	41,011	71.9	31,048	119.5
Dakota	(2)	(2)	(2)	1,421	248	.....	.....	.....	.....	6,047	425.5	1,173	473.0
Delaware	42,031	32,898	21,660	10,643	4,313	9,133	27.8	11,238	51.9	11,017	103.5	6,330	146.8
District of Columbia	10,513	8,630	10,473	2,263	789	1,883	21.8	[3] 1,843	[3] 17.6	8,210	362.8	1,474	186.8
Florida	41,975	35,044	15,492	6,208	3,172	6,931	19.8	19,552	126.2	9,284	149.5	3,036	95.7
Georgia	183,369	110,972	55,529	21,102	10,826	72,397	65.2	55,443	99.8	34,427	163.1	10,276	94.9
Idaho	15,145	4,010	972	546	311	11,135	277.7	3,038	312.6	426	78.0	235	75.6
Illinois	651,578	507,471	268,486	126,843	73,091	144,107	28.4	238,985	89.0	141,643	111.7	53,752	73.5
Indian Territory	12,104	5,053	349	.....	.....	7,051	139.5	4,704	1,347.9	349	.....	.....	.....
Indiana	336,932	296,926	174,060	109,960	76,851	40,006	13.5	122,866	70.6	64,100	58.3	33,109	43.1
Iowa	100,418	91,182	64,860	33,858	25,208	9,236	10.1	26,322	40.6	31,002	91.6	8,560	33.8
Kansas	83,039	55,518	34,882	13,468	6,360	27,521	49.6	20,636	59.2	21,414	159.0	7,108	111.8
Kentucky	162,829	136,122	75,836	45,917	31,928	26,707	19.6	60,286	79.5	29,919	65.2	13,989	43.8
Louisiana	245,745	187,492	29,446	11,256	24,924	58,253	31.1	158,046	536.7	18,190	161.6	[3] 13,668	[3] 54.8
Maine	126,818	89,257	43,748	20,759	9,465	37,561	42.1	45,509	104.0	22,989	110.7	11,294	119.3
Maryland	142,096	115,590	57,524	33,216	13,961	26,506	22.9	58,066	100.9	24,308	73.2	19,255	137.9
Massachusetts	690,467	576,525	355,226	171,397	78,502	113,942	19.8	221,299	62.3	183,829	107.3	92,895	118.3
Michigan	376,090	318,835	216,536	130,352	70,956	57,255	18.0	102,299	47.2	86,184	66.1	59,396	83.7
Minnesota	167,103	146,578	84,925	25,191	7,085	20,525	14.0	61,653	72.6	59,734	237.1	18,106	255.6
Mississippi	109,418	64,731	32,551	15,001	10,019	44,687	69.0	32,180	98.9	17,550	117.0	4,082	49.7
Missouri	221,215	173,271	139,189	72,587	48,418	47,944	27.7	34,082	24.5	66,602	91.8	24,169	49.9
Montana	32,356	32,008	2,122	544	822	348	1.1	29,886	1,408.4	1,578	290.1	[3] 278	[3] 33.8
Nebraska	34,012	31,048	17,196	2,999	1,865	2,964	9.5	13,852	80.6	14,197	473.4	1,134	60.8
Nevada	1,092	628	318	608	6,007	464	73.9	310	97.5	[3] 290	[3] 47.7	[3] 5,399	[3] 89.9
New Hampshire	102,439	89,905	47,652	18,595	8,787	12,534	13.9	42,253	88.7	29,057	156.3	9,808	111.6
New Jersey	386,770	281,306	162,178	72,792	32,307	105,464	37.5	119,128	73.5	89,386	122.8	40,485	125.3
New Mexico	5,097	3,283	1,502	427	252	1,814	55.3	1,781	118.6	1,075	251.8	175	69.4
New York	850,497	659,702	537,447	234,795	126,107	190,795	28.9	122,255	22.7	302,652	128.9	108,688	86.2
North Carolina	183,166	122,778	41,253	15,025	6,941	60,388	49.2	81,525	197.6	26,228	174.6	8,084	116.5
North Dakota	8,619	5,930	3,012	(4)	(4)	2,689	45.3	2,918	96.9	.....	.....	.....	.....
Ohio	1,028,665	732,006	387,840	222,502	129,577	296,659	40.5	344,166	88.7	165,338	74.3	92,925	71.7
Oklahoma	15,593	6,098	161	.....	.....	9,495	155.7	5,937	[3,687.6]	161	.....	.....	.....
Oregon	55,512	37,986	22,731	4,334	2,471	17,526	46.1	15,255	67.1	18,397	424.5	1,863	75.4
Pennsylvania	2,088,773	1,587,706	900,862	402,132	221,936	501,067	31.6	686,844	76.2	498,730	124.0	180,196	81.2
Rhode Island	140,322	115,735	85,327	41,335	23,546	24,587	21.2	30,408	35.6	43,992	106.4	17,789	75.5
South Carolina	157,432	80,913	29,117	11,995	4,537	76,519	94.6	51,796	177.9	17,122	142.7	7,458	164.4
South Dakota	8,483	9,256	4,456	(4)	(4)	[3] 773	[3] 8.4	4,800	107.7	.....	.....	.....	.....
Tennessee	161,919	116,715	68,728	33,388	18,467	45,204	38.7	47,987	69.8	35,340	105.8	14,921	80.8
Texas	155,312	110,943	65,515	28,026	11,214	44,369	40.0	45,428	69.3	37,489	133.8	16,812	149.9
Utah	12,162	7,606	2,562	1,154	331	4,556	59.9	5,044	196.9	1,408	122.0	823	248.6
Vermont	56,833	44,190	24,048	11,088	6,425	12,643	28.6	20,142	83.8	12,960	116.9	4,663	72.6
Virginia	143,917	109,392	45,590	19,710	8,410	34,525	31.6	63,802	139.9	25,880	131.3	11,300	134.4
Washington	150,312	77,749	37,675	3,210	1,411	72,563	93.3	40,074	106.4	34,465	1,073.7	1,799	127.5
West Virginia	124,212	84,234	44,755	28,456	17,136	39,978	47.5	39,479	88.2	16,299	57.3	11,320	66.1
Wisconsin	303,874	262,642	121,149	60,729	30,509	41,232	15.7	141,493	116.8	60,420	99.5	30,220	99.1
Wyoming	2,712	3,184	1,608	717	310	[3] 472	[3] 14.8	1,576	98.0	891	124.3	407	131.3

[1] For 1890 the horsepower represents owned and rented power. At subsequent censuses rented power was not segregated as to steam; the totals therefore represent owned power only.

[2] See North Dakota and South Dakota.

[3] Decrease.

[4] See Dakota.

The steel works and rolling mills of the country, as compared with the blast furnaces, employed steam units of a lower capacity, but such engines were far beyond the average size of units employed in all manufactures. There were 5,746 engines in steel works and rolling mills, with a total of 1,610,612 horsepower, or an average of 280 horsepower per unit. This is slightly above the average size in Pennsylvania, where 3,323 engines had a capacity of 799,323 horsepower, or 241 horsepower per unit, but in Illinois and Ohio the size was 405 horsepower, while in Alabama the average for 129 engines was not less than 440 horsepower. It is to be observed, moreover, that the size of the average steam unit for all blast furnaces and steel works and rolling mills has increased rapidly, having been 171 horsepower for 1890, 235 horsepower for 1900, and 325 horsepower for 1905.

The nature of an industry is fairly well indicated by the size of the steam units applied to it, although there are incidental factors to be taken into consideration that dictate in some industries the division of motive power into a number of units rather than its concentration into one or two generators of given capacity. At the census of 1905 the average size of steam engines in the cotton goods industry was 351 horsepower, while the average for blast furnaces was 490 horsepower. The average steam unit in steel works and rolling mills was 280 horsepower. The average in the worsted industry was 195 horsepower, but in the allied woolen industry it was only 117 horsepower. The average size of the unit in the smelting and refining of copper was 192; in the paper and wood pulp industry, 149; in flour and grist mills, 72; and in the manufacture of lumber and timber products, 58 horsepower.

In an era of building, which has witnessed the rapid development of construction by means of reinforced concrete, the great importance of the cement industry is indicated by the fact that the average capacity of steam units was 215 horsepower in the manufacture of cement, thus placing it next to steel works and rolling mills in average size of engines required. At the other end of the scale in the group of industries employing 50,000 horsepower and over is to be found the printing and publishing industry, the book and job branch of which employed engines whose average capacity was only 38 horsepower, while in that branch of the business including newspapers and periodicals the average fell to 26 horsepower. The influence of electrical distribution, however, is to be noticed here, in the fact that in the book and job branch the electric motors are more than three times as numerous as the steam engines, while the rented electric power is almost twice as great as the capacity of steam engines installed on the premises. It is obvious, therefore, that but for the intervention of the electric motor the steam engines would necessarily be of much greater capacity, and it is particularly in connection with such industries requiring minute and subdivided power that the electric motor has made greatest headway in comparison with steam.

Another aspect under which the use of steampower in manufactures may be regarded is that dealing with the average amount of power per establishment. In Table 1 it is shown that the total number of establishments reporting the use of power is 134,544, with a total of 14,641,544 horsepower. This gives an average of 108.8 horsepower per establishment. The iron and steel industry depends almost entirely upon steam for its power, and according to Table 14 of the Report on Manufactures, Part I, 189 blast furnaces reported a total of 825,749 horsepower at the census of 1905. This gives the high average of 4,369 horsepower per establishment. In like manner 413 steel works and rolling mills reported a total capacity of 1,896,759 horsepower, or 4,593 horsepower per establishment. Paper and wood pulp and cotton mills, on the other hand, are large users of waterpower. The 761 paper and wood pulp mills reported a total of 1,122,564 horsepower, which gives an average of 1,475 horsepower per establishment, while 1,073 mills devoted to cotton goods had a total of 1,031,843 horsepower, or 962 horsepower per establishment.

The Report on Power Employed in Manufactures, at the census of 1900, was accompanied by considerable data with regard to steam engines and steam turbines, emphasizing the marked tendency toward the adoption of larger units, and dwelling with special stress upon the important advances being realized in the perfecting of the modern steam turbine. At that time two principal types of turbines were in use in the manufacturing field in the United States, namely, the De Laval and the Parsons, both of foreign origin. The general principle of the turbine designed by the Swede, De Laval, is that of a single disk with several steam jets or nozzles applied to it, the nozzle having a divergent aperture in which the expansion of steam takes place. A single turbine disk revolves at a speed of several thousand revolutions per minute, this speed being reduced to that required for the main shaft by spiral gears. Turbines of this type have been applied in the manufacturing industries up to a capacity of 350 horsepower. At this point the Englishman, Parsons, stepped in with a type of turbine in which a series of disks mounted upon a common shaft alternate with parallel plates fixed within the casing of the shaft. The steam, admitted through a set of stationary vanes or buckets, impinges at an angle upon the first rotating disk and imparts motion in expanding, as it advances progressively, through the entire series of fixed and rotating buckets until its energy has been given up and it emerges into the exhaust. With horizontal turbines of this type the capacity of the unit has been carried up to several thousand horsepower, so that in this country one company building turbines of this type has introduced machines of a capacity as great as 10,000 horsepower or more. Intended to drive electric

generators, these turbines occupy a floor space of only 27 feet 27 inches by 13 feet 1½ inches, while the dimensions are only 47 feet 3 inches by 13 feet 1½ inches for the complete turbo-generator unit. Up to the beginning of 1904 a total production of not less than 700,000 horsepower of Parsons turbines had been recorded, including single installations of 10,000 horsepower, many of which were for manufacturing industries, and while these statistics have been in process of compilation, this total has been at least doubled. In the meantime a large number of other steam turbine manufacturers have also entered this promising field, both in Europe and in the United States, so that the turbine has ceased to be in any sense a novelty, and is now being closely watched and tested as to its durability and economic performance, both on land and on sea.

In the United States the most typical development is that which has been made with the Curtis turbine, which also makes use of the velocity of steam relieved of its pressure in the expansion nozzles at successive stages. Aside from the internal construction of stationary and revolving parts, a notable feature of the Curtis turbine has been the adoption of a vertical shaft, although in some smaller sizes the turbine is operated horizontally. The larger sizes are more particularly those furnished for the operation of dynamos, with the electrical generating portion carried vertically above the turbine. These have a capacity of 12,000 to 15,000 horsepower. One company which manufactures the turbines of this type, in its annual report for the year 1904, listed contracts for 154 steam turbines for 86 corporations and individuals, while a year later it was stated that orders had been received for no fewer than 535. As a great many of these have a capacity in excess of 1,000 horsepower and in the case of some industrial manufacturing and electrical establishments have reached a capacity of 5,000 horsepower and upward, the extent of the revolution in the utilization of steam caused by the introduction of the turbine can readily be imagined. It will, however, be some little time before all the economy claimed for the turbine in the matter of steam consumption, wear and tear, labor, attendance, and space occupied can be fully and accurately determined or established.

WATERPOWER.

Table 8 presents statistics of waterpower used in the states and territories as returned at each census from 1870 to 1905, with the amount and percentage of increase.

The total for 1905 was 1,647,969 horsepower, as compared with 1,454,229 horsepower in 1900, showing an increase of 193,740 horsepower and a percentage of increase of 13.3. The amount of gain was almost the same as that during the ten years from 1890 to 1900, when the percentage of increase was 15.1. Waterpower has not held its own but has steadily declined in relative importance since 1870, when it was 48.2 per cent of the whole, whereas for 1905 it was only 11.3 per cent. The warning previously given, must be borne in mind, that the statistics, while accurate, can hardly be accepted as revealing the actual state of affairs, owing to the fact that an increasing quantity of energy developed by waterpower is transmitted and utilized electrically, so that it is reported as electric power by manufacturing establishments.

The largest amount of waterpower used in manufactures at the census of 1905 was reported by the state of New York. The capacity in that state had increased from 335,411 horsepower for 1900 to 446,134 horsepower for 1905, a gain of considerably over 100,000 horsepower, and giving the state 27.1 per cent of the total for the whole country. The continued preponderance of New York in the use of waterpower is due largely to the utilization of, and the increase in, this kind of power in the paper and wood pulp industry, which increased from 191,117 horsepower in 1900 to 325,472 horsepower at the census of 1905. At both censuses waterpower formed over 80 per cent of the total power reported by this industry in the state. Of the total waterpower reported by New York in 1900 paper and wood pulp manufacturers used 57 per cent; at the census of 1905 the ratio had increased to 73 per cent.

The next largest utilization of waterpower in manufactures was reported by the state of Maine with 203,094 horsepower, followed closely by Massachusetts with 183,427 horsepower. The former state reflects the development of the utilization in the paper and wood pulp and cotton industries, and it is significant that, although the lumber industry is a large consumer of waterpower in Maine, the amount reported for 1905 was a decrease of 19.3 per cent since 1900. Massachusetts, as is well known, largely consumed this class of energy in the manufacture of paper and textile products, the latter chiefly cotton and wool. The fourth largest utilization on the list is that reported from Wisconsin, with 112,665 horsepower. Here again the paper and wood pulp industry accounted for a large proportion of the total amount, with flour and grist mills as the next largest consumer. In Wisconsin, as in Maine and in New York, the paper and wood pulp industry is the largest factor in waterpower employment, while in Massachusetts the cotton and wool industries are the largest.

The 4 states mentioned above accounted for 945,320 horsepower, or considerably more than one-half (57.4 per cent) of the total for the country. Other leading states were Vermont, with 76,237 horsepower; Connecticut, 66,808; Pennsylvania, 50,620; Michigan, 39,342; and Minnesota, 38,245. It is to be noted that California returned the small figure of 7,260 horsepower,

placing it far down the list, whereas, as a matter of fact, that state has witnessed perhaps more than any other of recent years the development of the waterpower of its sierras and rivers for long distance transmission, the hydraulic energy thus utilized serving mills and mines and factories all over the state.

As might be expected, in some of the states and territories where the aggregate of waterpower is least, the percentage of increase has been greatest, as the addition of a few hundred horsepower has been enough to double the capacity, but it is worthy of note that the increase in New York from 1900 to 1905 was 33 per cent; in Maine, 27.9 per cent; and in Wisconsin, 21 per cent. The development in Massachusetts was virtually at a standstill, and the same was true of Connecticut and Vermont, there being visible a tendency toward retrogression in certain parts of the New England region. It would indeed be an interesting study to determine how far the greater use of steam in some of the industries of the Northern states is due to the fact that the waterpowers have possibly been already developed to their full capacity.

TABLE 8.—WATERPOWER, WITH AMOUNT AND PER CENT OF INCREASE, BY STATES AND TERRITORIES: 1870 TO 1905.

[For 1900 the horsepower includes the hand trades and neighborhood industries, except custom gristmills, custom sawmills, and cotton ginning. Prior to 1900 the horsepower includes all hand trades and neighborhood industries.]

STATE OR TERRITORY.	HORSEPOWER.[1]					INCREASE.							
						1900 to 1905		1890 to 1900		1880 to 1890		1870 to 1880	
	1905	1900	1890	1880	1870	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.	Amount.	Per cent.
United States	1,647,969	1,454,229	1,263,343	1,225,379	1,130,431	193,740	13.3	190,886	15.1	37,964	3.1	94,948	8.4
Alabama	9,518	9,421	10,443	11,797	11,011	97	1.0	[2] 1,022	[2] 9.8	[2] 1,354	[2] 11.5	786	7.1
Alaska	89	117	161	.....	.....	[2] 28	[2] 23.9	[2] 44	[2] 27.3	161	.....	.....	.....
Arizona	267	400	329	160	10	[2] 133	[2] 33.3	71	21.6	169	105.6	150	1,500.0
Arkansas	584	734	1,778	2,024	1,545	[2] 150	[2] 20.4	[2] 1,044	[2] 58.7	[2] 246	[2] 12.2	479	31.0
California	7,260	4,680	5,122	4,850	6,877	2,580	55.1	[2] 442	[2] 8.6	272	5.6	[2] 2,027	[2] 29.5
Colorado	2,094	1,493	1,740	1,849	792	601	40.3	[2] 247	[2] 14.2	[2] 109	[2] 5.9	1,057	133.5
Connecticut	66,808	67,211	64,655	61,205	54,395	[2] 403	[2] 0.6	2,556	4.0	*3,450*	*5.6*	*6,810*	*12.5*
Dakota	[3]	[3]	[3]	803	76	.....	.....	.....	.....	789	98.3	727	956.6
Delaware	5,280	5,399	4,671	4,785	4,220	[2] 119	[2] 2.2	728	15.6	[2] 114	[2] 2.4	565	13.4
District of Columbia	710	369	810	880	1,100	341	92.4	[2] 441	[2] 54.4	[2] 70	[2] 8.0	[2] 220	[2] 20.0
Florida	118	116	496	939	528	2	1.7	[2] 380	[2] 76.6	[2] 443	[2] 47.2	411	77.8
Georgia	28,304	22,729	28,390	30,067	27,417	5,575	24.5	[2] 5,661	[2] 19.9	[2] 1,677	[2] 5.6	2,650	9.7
Idaho	1,078	1,605	1,024	1,136	295	[2] 527	[2] 32.8	581	56.7	[2] 112	[2] 9.9	841	285.1
Illinois	15,030	11,614	16,124	17,445	12,953	3,416	29.4	[2] 4,510	[2] 28.0	[2] 1,321	[2] 7.6	4,492	*34.7*
Indian Territory	59	155	75	.....	.....	[2] 96	[2] 61.9	80	106.7	75	.....	.....	.....
Indiana	9,685	11,964	16,305	21,810	23,518	[2] 2,279	[2] 19.0	[2] 4,341	[2] 26.6	[2] 5,505	[2] 25.2	[2] 1,708	[2] 7.3
Iowa	6,531	7,315	12,645	20,363	14,249	[2] 784	[2] 10.7	[2] 5,330	[2] 42.2	[2] 7,718	[2] 37.9	6,114	42.9
Kansas	6,544	7,521	7,764	7,611	1,789	[2] 977	[2] 13.0	[2] 243	[2] 3.1	153	2.0	5,822	325.4
Kentucky	4,603	4,247	6,272	9,012	7,640	356	8.4	[2] 2,025	[2] 32.3	[2] 2,740	[2] 30.4	1,372	18.0
Louisiana	266	313	66	90	142	[2] 47	[2] 15.0	247	374.2	[2] 24	[2] 26.7	[2] 52	[2] 36.6
Maine	203,094	158,788	106,520	79,717	70,108	44,306	27.9	52,268	49.1	26,803	33.6	9,609	13.7
Maryland	10,777	10,415	15,633	18,043	18,461	362	3.5	[2] 5,218	[2] 33.4	[2] 2,410	[2] 13.4	[2] 418	[2] 2.3
Massachusetts	183,427	181,907	159,787	138,362	105,854	1,520	0.8	22,120	13.8	21,425	15.5	32,508	30.7
Michigan	39,342	36,529	39,181	34,395	34,895	2,813	7.7	[2] 2,652	[2] 6.8	4,786	13.9	[2] 500	[2] 1.4
Minnesota	38,245	24,932	27,404	28,689	13,054	13,313	53.4	[2] 2,472	[2] 9.0	[2] 1,285	[2] 4.5	15,635	119.8
Mississippi	77	361	2,752	3,449	2,453	[2] 284	[2] 78.7	[2] 2,391	[2] 86.9	[2] 697	[2] 20.2	996	40.6
Missouri	3,727	3,113	4,758	8,162	6,644	614	19.7	[2] 1,645	[2] 34.6	[2] 3,404	[2] 41.7	1,518	22.9
Montana	10,315	9,717	666	954	795	598	6.2	9,051	1,359.0	[2] 288	[2] 30.2	159	20.0
Nebraska	7,221	7,513	6,127	5,495	1,446	[2] 292	[2] 3.9	1,386	22.6	632	11.5	4,049	280.0
Nevada	782	893	6	108	2,538	[2] 111	[2] 12.4	887	14,783.3	[2] 102	[2] 94.4	[2] 2,430	[2] 95.7
New Hampshire	100,274	105,711	69,033	69,155	68,291	[2] 5,437	[2] 5.1	36,678	53.1	[2] 122	[2] 0.2	864	1.3
New Jersey	18,197	20,161	17,645	27,066	25,832	[2] 1,964	[2] 9.7	2,516	14.3	[2] 9,421	[2] 34.8	1,234	4.8
New Mexico	149	153	323	932	659	[2] 4	[2] 2.6	[2] 170	[2] 52.6	[2] 609	[2] 65.3	*273*	*41.4*
New York	446,134	335,411	233,795	219,348	208,256	110,723	33.0	101,616	43.5	14,447	6.6	11,092	5.3
North Carolina	28,382	29,241	31,817	30,063	26,211	[2] 859	[2] 2.9	[2] 2,576	[2] 8.1	1,754	5.8	3,852	14.7
North Dakota	322	506	540	[4]	[4]	[2] 184	[2] 36.4	[2] 34	[2] 6.3	.....	.....	.....	.....
Ohio	18,149	17,848	27,683	38,641	44,746	301	1.7	[2] 9,835	[2] 35.5	[2] 10,958	[2] 28.4	[2] 6,105	[2] 13.6
Oklahoma	50	1	.....	.....	.....	49	4,900.0	1	.....	.....	.....	.....	.....
Oregon	20,660	19,263	9,469	9,255	5,806	1,397	7.3	9,794	103.4	214	2.3	3,449	59.4
Pennsylvania	50,620	54,601	82,534	110,276	141,982	[2] 3,981	[2] 7.3	[2] 27,933	[2] 33.8	[2] 27,742	[2] 25.2	[2] *31,706*	[2] 22.3
Rhode Island	29,231	28,171	27,258	22,240	18,481	1,060	3.8	913	3.3	5,018	22.6	3,759	20.3
South Carolina	31,097	27,586	16,309	13,873	10,395	3,511	12.7	11,187	68.2	2,526	18.2	3,478	33.5
South Dakota	1,069	1,099	1,052	[4]	[4]	[2] 30	[2] 2.7	47	4.5	.....	.....	.....	.....
Tennessee	9,995	11,078	15,477	18,564	19,514	[2] 1,083	[2] 9.8	[2] 4,399	[2] 28.4	[2] 3,087	[2] 16.6	[2] 950	[2] 4.9
Texas	2,277	1,557	2,633	2,508	1,830	720	46.2	[2] 1,076	[2] 40.9	125	5.0	678	37.1
Utah	3,252	3,366	2,492	3,535	2,160	[2] 114	[2] 3.4	874	35.1	[2] 1,043	[2] 29.5	*1,366*	*63.0*
Vermont	76,237	77,421	74,376	52,226	44,897	[2] 1,184	[2] 1.5	3,045	4.1	22,150	42.4	7,329	16.3
Virginia	25,946	23,550	30,663	37,464	41,202	2,396	10.2	[2] 13,113	[2] 35.8	[2] 801	[2] 2.1	[2] 3,738	[2] 9.1
Washington	4,642	6,853	4,851	1,185	1,412	[2] 2,211	[2] 32.3	2,002	41.3	3,666	309.4	[2] 227	[2] 16.1
West Virginia	6,404	5,425	10,542	9,454	10,195	979	18.0	[2] 5,117	[2] 48.5	1,088	11.5	[2] 741	[2] 7.3
Wisconsin	112,665	93,122	56,841	45,356	33,714	19,543	21.0	36,281	63.8	11,485	25.3	11,642	34.5
Wyoming	382	534	216	38	34	[2] 152	[2] 28.5	318	147.2	178	468.4	4	11.8

[1] For 1890 the horsepower represents owned and rented power. At subsequent censuses rented power was not segregated as to waterpower; the totals therefore represent owned power only.

[2] Decrease.

[3] See North Dakota and South Dakota.

[4] See Dakota.

The chief industries reporting the use of waterpower at the census of 1905 are those of cotton goods, with 1,218 water wheels of a capacity of 251,884 horsepower; flour and grist mills, 7,261 water wheels, with 258,111 horsepower; lumber and timber products, 2,496 wheels, with 103,657 horsepower; and paper and wood pulp, 3,149 wheels, with 717,979 horsepower. Worthy of note is the fact that the last-named industry alone accounts for nearly one-half of the waterpower used in the manufactures of the country. Another relatively large field of utilization is that of the woolen goods industry, in which 765 wheels are reported, with a capacity of 55,931 horsepower. In these industries, as with steam utilization, the size of water wheel depends largely upon the nature of the product. For example, in the flour and grist mill industry the average size of wheel was 36 horsepower. In the lumber industry the average was 42 horsepower. In the industry of cotton goods it rose to 207 horsepower per wheel, and in paper and wood pulp it attained a size of 228 horsepower. Even these figures are exceeded in several instances. For example, in the paper and wood pulp industry the 7 wheels employed in California are reported as having a capacity of 3,000 horsepower, or 429 horsepower each, while in West Virginia the 3 wheels reported had a capacity of 1,310 horsepower, or 437 horsepower each.

It is evident, therefore, that the capacity of individual units will far exceed the average in any industry or for the country as a whole, but it is again to the electrical transmission field that one must look for the striking examples. For instance, the Seattle-Tacoma Power Company at its Snoqualmie Falls plant has installed a "single wheel" turbine of 10,000 horsepower capacity, which is the largest turbine of its type ever built. Around Niagara Falls will be found the 12,500 horsepower vertical turbines of the Electrical Development Company, the 10,000 horsepower horizontal turbines of the Ontario Power Company, and the 10,000 horsepower vertical turbines of the Canadian Niagara Falls Power Company. All of these are double wheels, as each unit has two runners and a single shaft, driving a single generator. The single wheel turbine at Snoqualmie is of a horizontal shaft type, with radial inward flow and central axial discharge. The wheel is of 66 inches outside diameter by 9½ inches wide through the vanes. It has 34 vanes, which continue a short distance inward beyond the end plate of the wheel on the discharge side, thus giving a slight axial effect and making it a turbine of the mixed flow type rather than a pure radial flow turbine. The guide vanes are 32 in number, of the swivel type, connected by means of arms projecting radially inward to a rotatory ring concentric with the turbine shaft. The housing of the turbine is built up of cast iron segments. The turbine wheel or runner is an annular steel casting whose radial depth is only enough to contain the vanes. This single wheel, at 260 feet head, is employed to develop as much energy as the entire former installation consisting of 10 impulse wheels, and under test at 84 per cent efficiency has shown an output of 10,000 horsepower. The machine weighs about 190,000 pounds, exclusive of the steel supply pipe and the draft tube.

Under the same general head of utilization of waterpower, water motors might be separately considered, but these are insignificant in number and size, and such information as is valuable or pertinent in regard to them can be obtained readily from Tables 12, 13, and 14 of the Report on Manufactures, Part I, census of 1905.

No separate statistics are given as to overshot or undershot water wheels. The discussion of generators has been treated entirely from the standpoint of turbines, as that type of hydraulic machinery has completely superseded all other classes except impact wheels. The latter still have an extensive field of use, particularly in the far western region and on the Pacific coast, where, under heads of several hundred feet and at high speeds of revolution, they are increasingly numerous and find extensive employment. At Manitou, near the Garden of the Gods, Colo., the Pikes Peak Hydro-Electric Company has three wheels operating under a static head of 2,417 feet. The plant utilizes water belonging to a city waterworks plant, a supply which was previously wasted. This plant utilizes about 2,200 feet effective head of total fall between the mountain intakes and the reservoirs, the remainder being lost in pipe friction. Another instance that may be cited is that at Bishop, Cal., of the Nevada Mining and Milling Company, where two wheels operating under a static head of 1,065 feet, and each of a capacity of 1,000 horsepower at 450 revolutions per minute, are generating and transmitting electrical energy to the Goldfield and Tonapah mining districts of Nevada.

ELECTRIC POWER.

Table 9 shows, by states, the electric horsepower, with the amount and per cent of increase, reported at the censuses of 1890, 1900, and 1905.

As previously noted, the census statistics of power contain an element of duplication, especially of electric power. When electric power is generated by a manufacturer, the horsepower of the motors reported is a duplication of the primary generators. Allowance should be made for this fact in considering the statistics of total power.

No electric power was reported until the census of 1890, when the returns included 15,569 horsepower. At the census of 1900 the capacity of owned electric power had risen to 310,661 horsepower, showing an increase for the period of nearly nineteenfold. At the census of 1905 the amount of owned electric power had risen to 1,150,891 horsepower, being 270.5 per cent increase for the five years. This service was furnished

through 73,120 motors. The full story of electrical development is brought out, however, more clearly by the subdivision of rented power. From this it would appear that while the "other kind" of rented power, which is chiefly steam and water, increased from 136,913 horsepower in 1900 to 191,313 at the census of 1905, rented electric horsepower rose from 182,562 to 441,592 horsepower. This service was furnished through 61,590 motors. If, therefore, the rented electric power be added to that owned by the manufacturing establishments, it will be seen that the total capacity of the 134,710 electric stationary motors was 1,592,483 horsepower, approximating the total returned for waterpower. The average capacity of electric motors owned was 16 horsepower, while that of motors driven by rented electric energy was only 7 horsepower.

These statistics bring out in a striking manner the notable development of the utilization of electrical energy in manufacturing, and Table 9 indicates the concentration of this motive power in the states and territories. The table includes both the owned and rented power.

TABLE 9.—ELECTRIC POWER, WITH AMOUNT AND PER CENT OF INCREASE, BY STATES AND TERRITORIES: 1890 TO 1905.

[For 1900 the horsepower includes the hand trades and neighborhood industries, except custom gristmills, custom sawmills, and cotton ginning. Prior to 1900 the horsepower includes all hand trades and neighborhood industries.]

STATE OR TERRITORY.	HORSEPOWER.[1]			INCREASE.			
				1900 to 1905		1890 to 1900	
	1905	1900	1890	Amount.	Per cent.	Amount.	Per cent.
United States	1,592,483	493,223	15,569	1,099,260	222.9	477,654	3,068.0
Alabama	10,114	3,421	51	6,693	195.6	3,370	6,607.8
Alaska	8	287	.....	[2] 279	[2] 97.2	287	.....
Arizona	4,821	534	.....	4,287	802.8	534	.....
Arkansas	2,191	480	31	1,711	356.5	449	1,448.4
California	49,575	15,762	393	33,813	214.5	15,369	3,910.7
Colorado	15,730	1,896	58	13,834	729.6	1,838	3,169.0
Connecticut	34,579	12,925	205	21,654	167.5	12,720	6,204.9
Delaware	5,764	1,870	104	3,894	208.2	1,766	1,698.1
District of Columbia	1,761	348	70	1,413	406.0	278	397.1
Florida	2,960	302	3	2,658	880.1	299	9,966.7
Georgia	15,556	2,698	157	12,858	476.6	2,541	1,618.5
Idaho	1,702	6	2	1,696	28,266.7	4	200.0
Illinois	165,265	49,235	939	116,030	235.7	48,296	5,143.3
Indian Territory	132	.....	.....	132	.....	.....	.....
Indiana	33,582	7,903	323	25,679	324.9	7,580	2,346.7
Iowa	8,663	6,222	194	2,441	39.2	6,028	3,107.2
Kansas	10,326	3,426	110	6,900	201.4	3,316	3,014.5
Kentucky	10,690	3,415	100	7,275	213.0	3,315	3,315.0
Louisiana	6,752	2,069	454	4,683	226.3	1,615	355.7
Maine	26,587	9,659	191	16,928	175.3	9,468	4,957.1
Maryland	18,823	4,174	212	14,649	351.0	3,962	1,868.9
Massachusetts	91,012	32,828	2,327	58,184	177.2	30,501	1,310.7
Michigan	39,970	12,088	577	27,882	230.7	11,511	1,995.0
Minnesota	14,427	6,300	280	8,127	129.0	6,020	2,150.0
Mississippi	1,367	590	3	777	131.7	587	19,566.7
Missouri	37,671	12,725	618	24,946	196.0	12,107	1,959.1
Montana	7,979	3,184	43	4,795	150.6	3,141	7,304.7
Nebraska	8,126	2,398	49	5,728	238.9	2,349	4,793.9
Nevada	550	1	.....	549	54,900.0	1	.....
New Hampshire	12,301	3,471	42	8,830	254.4	3,429	8,164.3
New Jersey	69,301	15,857	487	53,444	337.0	15,370	3,156.1
New Mexico	233	8	.....	225	2,812.5	8	.....
New York	222,111	77,598	2,447	144,513	186.2	75,151	3,071.1
North Carolina	5,553	2,733	44	2,820	103.2	2,689	6,111.4
North Dakota	477	171	2	306	178.9	169	8,450.0
Ohio	144,407	42,157	1,705	102,310	242.7	40,452	2,372.6
Oklahoma	778	12	.....	766	6,383.3	12	.....
Oregon	5,223	2,690	37	2,533	94.2	2,653	7,170.3
Pennsylvania	346,797	107,746	2,162	239,051	221.9	105,584	4,883.6
Rhode Island	15,477	4,895	295	10,582	216.2	4,600	1,559.3
South Carolina	32,162	6,061	8	26,101	430.6	6,053	75,662.5
South Dakota	339	234	3	105	44.9	231	7,700.0
Tennessee	6,586	2,193	106	4,393	200.3	2,087	1,968.9
Texas	10,299	3,217	166	7,082	220.1	3,051	1,838.0
Utah	4,272	2,829	64	1,443	51.0	2,765	4,320.3
Vermont	7,238	2,173	34	5,065	233.1	2,139	6,291.2
Virginia	12,687	5,617	105	7,070	125.9	5,512	5,249.5
Washington	15,290	3,137	63	12,153	387.4	3,074	4,879.4
West Virginia	5,199	454	5	4,745	1,045.2	449	8,980.0
Wisconsin	48,878	13,137	295	35,741	272.1	12,842	4,353.2
Wyoming	132	87	5	45	51.7	82	1,640.0

[1] For 1905 and 1900 the horsepower represents owned and rented power; for 1890, owned power only.

[2] Decrease.

There was an extraordinary development from 1900 to 1905 in the states distinguished chiefly for heavy manufacturing on a large scale. In Pennsylvania the capacity rose from 107,746 to 346,797 horsepower, or 221.9 per cent. In the state of New York there was an increase in capacity from 77,598 to 222,111 horsepower, or 186.2 per cent. In Illinois the capacity rose from 49,235 to 165,265 horsepower, or 235.7 per cent. In Ohio it rose from 42,157 to 144,467 horsepower, or 242.7 per cent. In Massachusetts the capacity rose from 32,828 to 91,012 horsepower, or 177.2 per cent. The figures for New Jersey are equally striking, the capacity increasing from 15,857 to 69,301 horsepower, or 337 per cent.

In California the effect of electric energy transmission is seen especially in the fact that while "other kind" of rented horsepower actually fell off in the period from 1900 to 1905, rented electric horsepower increased from 9,624 to 39,363, the latter comprising almost 80 per cent of all electric power reported by the state. In Iowa the rented horsepower other than electric fell off from 642 horsepower to 523, but rented electric power increased from 2,613 to 5,107 horsepower. The same tendency was manifested in other states, as for instance in Maryland, where the other rented power declined from 1,650 to 1,359 horsepower, while rented electric power increased from 733 to 3,309 horsepower. South Carolina presents an extraordinary example of this encroachment of the newer motive power resulting in an entire reversal of the figures. Thus in 1900 rented electric power was only 185 and other rented power 3,320 horsepower. At the census of 1905 rented electric power in that state had increased to 8,451 horsepower and other rented power had declined to the insignificant total of 80 horsepower. A more extreme revolution it would probably be hard to find in industrial history.

Of late years the electric motor has come to be a very important factor in iron and steel works and rolling mills. At the census of 1905, 12,183 motors were employed in such mills, with a capacity of 247,460 horsepower, supplemented by 6,798 rented electric horsepower. In blast furnaces 1,370 motors were employed, with a total capacity of 52,471 horsepower, associated with 6,320 rented electric horsepower. In the manufacture of structural ironwork 2,324 motors were employed of 27,247 horsepower, supplemented by 7,327 rented electric horsepower, and 9,834 motors of 109,294 horsepower were devoted to the manufacture of foundry and machine shop products, and in addition 44,983 rented electric horsepower was used. It will be seen that these four allied iron and steel industries employed directly electric motors of a capacity of 436,472 horsepower and rented power to the extent of 65,428 horsepower, a total of 501,900 horsepower, or almost one-third of the total for all industries.

A large aggregate capacity was also employed for the construction and repair of cars, etc., by steam railroads, namely, 3,028 motors of 46,561 horsepower and 6,074 rented horsepower, and there should be added 717 motors of 14,189 horsepower, supplemented by 316 rented horsepower, employed specifically for the construction of steam cars by other than railroad companies. The industry of cotton goods employed 767 motors of 52,734 horsepower, supplemented by 13,565 rented horsepower. For the production of electrical machinery, apparatus, and supplies, 6,141 motors were employed of 40,440 horsepower, supplemented by 21,313 rented horsepower. In several instances the rented power exceeded that owned or generated by the manufacturers, and sometimes to a considerable extent. For example, for flour and grist mills 232 motors were returned of 4,724 horsepower, while the rented electric power amounted to 15,584 horsepower. In planing mills 332 motors of 4,489 horsepower were owned, but the rented electric horsepower was more than twice as great. This feature was, however, most marked in the printing and publishing industries. In the book and job printing offices 1,386 motors were employed of 4,848 horsepower, but the rented electric power was not less than 30,095 horsepower. In like manner in newspaper and periodical plants 1,531 motors were employed of 9,558 horsepower, but 39,771 horsepower was reported as rented. The printing arts lend themselves peculiarly to the subdivision of power and to the utilization of electric motors, and the business is also carried on to a great extent in populous centers, so that central station sources of supply can be drawn upon. The result is that even in great cities, such as New York, the largest newspapers have transmitted to them from distant power houses electrical energy for the propulsion of their presses and the operation of other machinery necessary to the publishing of their daily issues.

As already noted in connection with other industries, the nature of the raw material or the class of product is a factor in determining the size of the motors. The largest owned electric motors, on the average, at the census of 1905 are to be found in the cotton goods industry, with a capacity of 69 horsepower; in the paper and wood pulp industry, of 54 horsepower; in woolen goods, of 46 horsepower; and in worsted goods, of 41 horsepower. Those in blast furnaces had an average capacity of 38 horsepower and in steel works and rolling mills of 20 horsepower; from this the size dwindles down to those employed in book and job printing offices, with an average of slightly less than 3½ horsepower. It should not be understood, however, that these are other than average figures, as motors of very large capacity, far in excess of those usually employed in the cotton industry, are being applied to rolling mill and blast furnace purposes. For example, motors of 1,500 horsepower capacity at a speed of 100 revolutions per minute, and capable of being driven far beyond this point, have been installed in a large rolling mill; and motors of 1,200 horsepower have been installed for reversing rolls, while

1,500 horsepower motors have also been applied to blooming mills.

The use of electric motors is now so general that it is difficult to name any industry, manufacturing or otherwise, to which this modern mechanism has not been applied. The figures cited above are a sufficient indication of the remarkably rapid adoption of electric power that is going on, but the economies due to the change from long and short lines of belt shafting to the application of power directly at the point of utilization by the motor have not yet been fully worked out or realized in practice. There is hardly a class of machine tools which is not to-day in a transitional stage, owing to the efforts that are being made not only to abandon the line shafting but to build the electric motors directly into the tool or appliance itself. In fact, this principle of direct application or minute subdivision of applied power has gone so far that several motors are now being fitted or applied directly to the one tool or piece of apparatus, each motor being limited to its own specific function in raising or lowering, turning or reversing, etc. It may be safely asserted that practically all the newer factories and shops in the United States of any size, constructed within the past five years, have an electrical drive either exclusively or for most purposes. In some instances the motors have been applied directly to the tools, and in others one motor drives a constant speed countershaft from which the separate machines receive their power through leather belts or special forms of link belt drives. As between direct connected and belted motors, it is a question of the interbalancing of advantages—the capital outlay being less where the large shaft-driving motors are employed, while the energy consumption is also reduced by their higher efficiency. On the other hand, the incorporation of the motor directly into the machine drive through gears or short link belts without intermediate shaft belting is found to offer many advantages, and there is a constant effort in this direction of simplicity of drive on the part of both machine builders and the manufacturers of motors. The general advantages due to the adoption of electric power are common to both methods and are those connected with economy, the greater flexibility and handiness, the lessening of risk of total breakdown, and the generally greater refinement of speed or delicacy of operation.

Reference has been made to the subject of electric energy transmission, and a tabular statement is presented giving a list of some of the most important and interesting electrical transmission plants on the American continent.

Electrical transmission plants.

Name.	Location.	Maximum transmitting voltage.	Total capacity, horsepower.	Frequency of cycles.	Length of line (miles).
Edison Electric Company, Kern River Station	Los Angeles, Cal	75,000	26,000	50	139
American River Electric Company	Placerville, Cal	60,000	4,000	60	90
Northern California Power Company	Redding, Cal	22,000	7,000	60	60
California Gas and Electric Company	San Francisco, Cal	70,000	60,000	60	100 to 200
Siskiyou Electric Power Company	Yreka, Cal	22,500	22,500	60	9
Electric Development Company	Colorado	60,000	37,000	25	90
Animas Canal Reduction Water Power and Development Company	Durango, Colo	50,000	24,000	60	55
Atlanta Water and Electric Power Company	Morgan Falls, Ga	22,000	14,000	25	5
Great Northern Power Company	Duluth, Minn	60,000	60,000	25	14
Columbia Improvement Company	Taylors Falls, Minn	50,000	13,500	60	38
Spring River Power Company	Joplin, Mo	33,000	4,000	60	28
Missouri River Power Company	Canyon Ferry, Mont	55,000	10,000	60	65
Missouri River Power Company	Helena, Mont	60,000	5,000	60	60
Cataract Power and Conduit Company	Niagara Falls, N. Y	22,000	50,000	25	25
Ontario Power Company	Niagara Falls, N. Y	60,000	70,000	25	185
Whitney Reduction Company	Salisbury, N. C	60,000	35,000	60	75
Condor Water and Power Company	Tolo, Oreg	22,000	1,000	60	100
Juniata Hydro-Electric Company	Huntingdon, Pa	45,000	7,500	60	30
Belton Power Company	South Carolina	22,500	5,000	60	14
Telluride Power Transmission Company	Provo, Utah	40,000	12,000	60	55
Utah Sugar Company	Salt Lake City, Utah	23,000	3,000	60	9
Nooksack Falls Power Company	Myrtle Falls, Wash	38,000	2,000	60	40
Washington Water Power Company	Post Falls, Wash	60,000	24,000	60	110
Columbus Improvement Company	Seattle, Wash	55,000	28,700	60	47
Puget Sound Power Company	Seattle, Wash	52,000	35,000	60	47
Seattle-Tacoma Power Company	Snoqualmie, Wash	33,000	14,700	60	4
Madison River Power Company	Wisconsin	80,000	24,000	60	60
Foreign.					
Mexican Light and Power Company	City of Mexico	60,000	40,000	50	173
Hamilton Cataract Power and Light Company	Hamilton, Ontario	45,000	30,400	66	36
Shawinigan Water and Power Company	Montreal, Canada	50,000	20,000	30	80
Shawinigan Power Company	Montreal, Canada	56,000	15,000	25	85
Canadian Niagara Falls Power Company	Niagara Falls	60,000	70,000	25	90
Niagara, Lockport, and Ontario Company	Niagara Falls, N. Y	60,000	40,000	25	168
Winnipeg General Power Company	Winnipeg, Manitoba	60,000	25,000	60	67

As will be seen from this statement, several of these lines are over 100 miles in length, and in one instance, in California, the total length of line is now 200 miles. It will also be observed that the total capacity of these plants ranges upward in many instances to 50,000, 60,000, and 70,000 horsepower. The line

voltage which not long ago electrical engineers were reluctant to carry above 10,000 volts now reaches, as is shown by the table, 40,000, 60,000, and 80,000 volts, and pressures are under discussion which range even higher than this. It is from such plants as these that a large amount of the rented electric power referred to above is derived, as well as from the central station power plants in cities and towns. All the plants enumerated in the above statement are based upon the utilization and conversion of hydraulic energy and its transmission and distribution in the shape of electrical energy. At the same time it will be observed that but for the adoption of electrical methods it would have been found impossible to develop advantageously many of these waterpowers hitherto running to waste. Electricity has conferred a double benefit not only in saving that which was hitherto lost, but in enabling manufacturers and miners to locate at points where their processes can be carried on with greatest economy and profit and to employ there power which would otherwise have been beyond their reach or beyond their resources. The effect of this electrical revolution can not yet be fully apprehended, as it is in its earlier stages; but there can be no doubt as to the profound impression that it is making upon every branch of industry, including all the departments of manufacture.

The utilization of waterpower through long distance transmission lines and with the aid of electric motors for manufacturing and kindred purposes is intimately associated with the question of coal output and the general exhaustion of the fuel supplies. This exhaustion, while not imminent, has already made its possible ultimate effects felt in the gradual increase in the cost of natural gas and petroleum and in the steady increase in the cost of coal, which necessarily becomes more expensive as it is more difficult to mine at lower depths. The resort, therefore, to remote waterpowers and to the intervention of electric motors was in a sense inevitable and explains the eagerness with which water privileges, falls, and river courses are being acquired and developed throughout the country for the purposes of electrical transmission. Another aspect of the case is the strictly economic one. It is undoubtedly a fact that the use of waterpower in this manner has greatly lessened power costs in manufacturing. Taking the electrical utilization of Niagara as a basis, although the power development there is neither the dearest nor the cheapest, it is found that the industries at that point are paying not to exceed $25 per horsepower for a continuous year's service of 8,760 hours. The anxiety to seize upon the resources of Niagara, estimated at a total power of 4,000,000 horsepower, may therefore be understood. The utilization of one-half of this power, namely, 2,000,000 horsepower, would effect an annual saving of 12,000,000 tons of coal. Upon the basis of 3,000 hours per annum, taking the value of this fuel at $2.50 per ton, the saving effected would amount to $30,000,000. Considering this to represent 40 per cent of the cost of development annually of 2,000,000 horsepower by steam, the total expense is found to be $75,000,000.[1] Such figures as these, applied in a general way to the entire hydroelectrical development now so actively in progress throughout the country, give a rough idea of the rewards to capital and the economies to manufacturers involved in this industrial and engineering change of methods.

GAS ENGINE POWER.

The increase in the number, size, and total capacity of gas and gasoline engines has been another marked feature of industrial and engineering development in connection with manufactures. Table 10 presents the statistics of this form of power, by states, from 1890 to 1905.

The number of gas and gasoline engines increased from 14,334 in 1900 to 21,525 at the census of 1905, their capacity from 134,742 horsepower to 289,514, and their percentage of the total horsepower employed in manufacturing establishments rose from 1.3 to 2. When it is recalled that at the census of 1890 the capacity of gas engines in manufacturing establishments was only 8,930 horsepower and is now over thirty times greater, it will be seen that a really remarkable change has taken place. The percentage of gain in horsepower from 1900 to 1905 was 114.9, and this was exceeded only by the percentage of gain in electric power.

The internal combustion engine has evidently not only retained its popularity for reasons of convenience, economy, and efficiency, but has gained ground, and is to-day taken very seriously as a source of motive power on a large scale. The average size of gas engines in 1900 was 9.4 horsepower, whereas at the census of 1905 it had increased to nearly 13.5 horsepower. This gain in size, however, should not be taken to mean that the number of small gas engines is less than it was, as it is in the very small sizes that this appliance still experiences its greatest demand. The statistics are influenced very considerably by the utilization on a large scale of producer gas in connection with the iron and steel industries. In such industries, however, as printing and publishing, gas engines of an extremely small capacity are used. In the book and job branch there were 1,001 engines of a capacity of 6,136 horsepower reported at the census of 1905, or an average of 6 horsepower per engine. In the newspaper and periodical department the average was even less, as the 5,147 gas engines used had a capacity of only

[1] These figures appeared in a statement made by Mr. W. J. Clark to the Hon. T. E. Burton, chairman of the House Committee on Rivers and Harbors, during a discussion of the Niagara power bill in 1906.

18,137 horsepower, or less than 4 horsepower per unit. As a matter of fact, it is in the gas and gasoline engines that one finds to-day perhaps the widest range in size among motive power appliances, unless the electric dynamo and the electric motor be considered as generically and essentially the same.

The use of gas and gasoline power is very general throughout the country, as it is found in every state and territory. Pennsylvania was the most conspicuous state in this respect at the census of 1905, with 68,209 horsepower capacity. In New York there was a capacity of 44,288 horsepower; in Ohio, of 35,101 horsepower; in Indiana, of 21,171 horsepower; in Illinois, of 12,319 horsepower; in Wisconsin, of 11,356 horsepower; and in Michigan, of 10,534 horsepower.

The gasoline engine is necessarily more widely used than the gas engine, gasoline being obtainable everywhere, while the gas engine usually depends upon its supply of fuel from city gas works. Hence by far the larger number of gas engines, and those small ones, are to be found in the denser centers of population, where the engine can be employed for the countless minor or finer branches of industry. Unlike the steam engine, it can be installed practically on any floor of a building when surrounded by appropriate safeguards against fire. It is in this respect, however, that of recent years the smaller gas engine has encountered the sharp competition of the electric motor. The latter, in many of the essentials of convenience, economy, adaptability, and freedom from danger, comes into competition with the gas engine as does that appliance with the steam engine.

TABLE 10.—GAS AND GASOLINE POWER, WITH AMOUNT AND PER CENT OF INCREASE, BY STATES AND TERRITORIES: 1890 TO 1905.

[For 1900 the horsepower includes the hand trades and neighborhood industries, except custom gristmills, custom sawmills, and cotton ginning. Prior to 1900 the horsepower includes all hand trades and neighborhood industries.]

STATE OR TERRITORY.	HORSEPOWER.[1]			INCREASE.			
				1900 to 1905		1890 to 1900	
	1905	1900	1890	Amount.	Per cent.	Amount.	Per cent.
United States	289,514	134,742	8,930	154,772	114.9	125,812	1,408.9
Alabama	472	376	14	96	25.5	362	2,585.7
Alaska	91	.....	.....	91	.....	.....	.....
Arizona	1,392	371	.....	1,021	275.2	371	.....
Arkansas	482	326	7	156	47.9	319	4,557.1
California	6,292	3,244	361	3,048	94.0	2,883	798.6
Colorado	317	519	36	[2] 202	[2] 38.9	483	1,341.7
Connecticut	3,393	1,608	215	1,785	111.0	1,393	647.9
Delaware	412	315	80	97	30.8	235	293.8
District of Columbia	311	338	91	[2] 27	[2] 8.0	247	271.4
Florida	320	173	63	147	85.0	110	174.6
Georgia	632	365	119	267	73.2	246	206.7
Idaho	127	28	.....	99	353.6	28	.....
Illinois	12,319	8,758	708	3,561	40.7	8,050	1,137.0
Indian Territory	283	45	.....	238	528.9	45	.....
Indiana	21,171	12,295	176	8,876	72.2	12,119	6,885.8
Iowa	4,486	4,524	70	[2] 38	[2] 0.8	4,454	6,362.9
Kansas	6,923	2,530	77	4,393	173.6	2,453	3,185.7
Kentucky	1,938	1,096	223	842	76.8	873	391.5
Louisiana	961	462	213	499	108.0	249	116.9
Maine	3,063	2,178	10	885	40.6	2,168	21,680.0
Maryland	4,377	3,139	175	1,238	39.4	2,964	1,693.7
Massachusetts	7,487	4,074	289	3,413	83.8	3,785	1,309.7
Michigan	10,534	5,603	237	4,931	88.0	5,366	2,264.1
Minnesota	4,710	3,624	126	1,086	30.0	3,498	2,776.2
Mississippi	220	144	8	76	52.8	136	1,700.0
Missouri	4,960	3,279	457	1,681	51.3	2,822	617.5
Montana	74	85	17	[2] 11	[2] 12.9	68	400.0
Nebraska	2,035	1,919	58	116	6.0	1,861	3,208.6
Nevada	125	39	48	86	220.5	[2] 9	[2] 18.8
New Hampshire	1,395	571	3	824	144.3	568	18,933.3
New Jersey	9,070	3,284	135	5,786	176.2	3,149	2,332.6
New Mexico	114	64	.....	50	78.1	64	.....
New York	44,288	16,221	1,990	28,067	173.0	14,231	715.1
North Carolina	2,102	388	42	1,714	441.8	346	823.8
North Dakota	645	759	12	[2] 114	[2] 15.0	747	6,225.0
Ohio	35,101	14,230	1,183	20,871	146.7	13,047	1,102.9
Oklahoma	706	155	.....	551	355.5	155	.....
Oregon	371	195	2	176	90.3	193	9,650.0
Pennsylvania	68,209	26,246	919	41,963	159.9	25,327	2,755.9
Rhode Island	1,247	427	18	820	192.0	409	2,272.2
South Carolina	230	323	97	[2] 84	[2] 26.0	226	233.0
South Dakota	1,307	1,270	32	127	10.0	1,238	3,868.8
Tennessee	1,084	593	54	491	82.8	539	998.1
Texas	1,876	968	157	908	93.8	811	516.6
Utah	59	89	10	[2] 30	[2] 33.7	79	790.0
Vermont	1,483	1,120	10	363	32.4	1,110	11,100.0
Virginia	1,715	748	78	967	129.3	670	859.0
Washington	493	189	3	304	160.8	186	6,200.0
West Virginia	6,569	1,045	33	5,524	528.6	1,012	3,066.7
Wisconsin	11,356	4,358	274	6,998	160.6	4,084	1,490.5
Wyoming	88	42	.....	46	109.5	42	.....

[1] Represents owned power only.

[2] Decrease.

The size of gas engine units depends, as with other motive powers, to some extent upon the nature of the industry to which its power is furnished. The size of the unit in the printing and publishing industries shows a capacity of from 4 to 6 horsepower. In the manufacture of cement, however, while only 25 engines were reported at the census of 1905, their average capacity was over 122 horsepower. In blast furnaces only 27 were reported, but their capacity reached nearly 139 horsepower each, while in steel works and rolling mills 53 were installed, with a capacity of 11,806 horsepower, or an average of not less than 223 horsepower per unit. In reality, however, the gas engine with which the public is still most familiar in connection with motive power purposes is the small type connected to city gas mains. One interesting feature of the consolidation of gas and electric lighting supply companies has been the change in method of utilization. The very small gas engines may have been displaced in many instances by the electric motor, but the productive gas capacity thus set free has in turn been utilized again at the central plant to drive large gas engines attached to the dynamos. The latter furnish current to the small electric motors, thus accomplishing the same work that the small gas engines did previously. In some of these systems, natural fuel gas is also employed, an interesting example of which is seen in the gas engine plant of a street railway system in Pennsylvania. With a capacity of 1,000 horsepower this plant utilizes, at a pressure of 125 pounds, gas which is furnished by 32 wells lying in the famous Bradford sand strata of Elk county. In view of its apparent tendency, however, to diminish in volume and pressure, the natural gas supply can not be regarded as a permanent basis for the development of larger types of gas engines for manufacturing and other purposes. Thus a great deal of activity and a large amount of inventive ability are being applied to the development and perfection of gas "producer" plants. It is stated that anthracite producers for the supply of gas to such engines have already reached a high degree of perfection, are reasonable in price, simple to operate, and show an efficiency 75 to 80 per cent above that of the best steam boiler and furnace. The bituminous producer has not yet been completely worked out. In this type the volatiles are completely converted into fixed gases without serious loss and without complication of the operating system. A number of excellent appliances are already on the market for reducing bituminous coal, but when the gas is to be employed in engines of this character they are associated with special and often complex cleaning apparatus, scrubbers, and the like, for the purpose of purification before the gas is admitted to the combustion chamber. Generally the bituminous producers are of lower efficiency than the anthracite, but even existing types are reported to reach or even exceed 70 per cent efficiency, equaling that of the best steam boiler and furnace.

One of the most notable developments of the last few years in connection with the perfecting of the large gas engines has been the utilization of blast furnace gas engines. Greater economy is thus attained through the utilization of a by-product of which hitherto a very large percentage had gone to waste. A noteworthy instance of work in this direction is an equipment at Pittsburg, Pa. This plant was the first large gas power installation in America to use blast furnace gas passed through double-acting, four-cycle engines of great capacity. Support had previously been given to the internal combustion type of prime movers. But during the period of this report further interest in the subject was evidenced when the largest single operator undertook the utilization of waste gas by the purchase of 12,000 horsepower in gas driven blowing engines and 2,500 horsepower in a gas driven electrical generating unit. A new plant at Gary, Ind., comprises about 25,000 horsepower of blast furnace gas engines. A Pittsburg plant will comprise, when complete, no fewer than 12 large units for blower purposes of 3,000 horsepower each. In design these engines follow the general line of smaller units and are of the twin tandem double acting style with center hung fly wheel. Although an uninterrupted supply of air is furnished for blowing purposes, the duty imposed is by no means uniform. Owing to changes in the compactness of furnaces the air pressure must vary in proportion. The usual range is 14 to 20 pounds per square inch, except when the furnaces are tapped. At such times the pressure is reduced to 5 pounds, but when the furnaces are closely packed it may rise to 20 pounds. These variations have to be provided for by sensitive centrifugal regulators. Ordinarily compressed air is used for starting, one minute usually being sufficient, but it is worthy of note that these large units can be started and placed under full load in 53 seconds from the time of turning on the air. Since the starting is entirely automatic when the engine goes into operation, only the gas and air valves require the attention of the operator.

An explanation of the increasing favor for large gas engines in metallurgical works is furnished by Mr. R. E. Mathot, in a discussion of the subject before the American Society of Mechanical Engineers. An ordinary blast furnace of a daily 24-hour output of 100 tons of iron liberates about 315,000 cubic feet of gas, which is available for motive power and has an average value of 110 British thermal units. This volume of gas generates in steam plants about 2,500 horsepower, while in modern and improved gas engine plants it gives 4,200 horsepower. It is a difference of 1,700 horsepower, or about 70 per cent, in favor of the gas engine. The same authority asserts that among 50 smelting works in the iron and steel industry in Germany, 42 are already using or have ordered large

engines for dealing with the gas generated in the blast furnaces, smelting, or coke ovens. These works represent 350 units, with an aggregate output of about 400,000 horsepower. The largest of the plants is of 35,000 horsepower, while there are 15 works with plants of from 10,000 to 12,000 horsepower.

OTHER POWER.

Under the heading "other power," as distinguished from steam, water, gas, and electric power, Table 1 of this report includes an item of 92,154 horsepower owned. This compares with 49,985 in 1900. A large part of the power included in this group is pneumatic, although probably some hot air engines also are included. The general introduction of pneumatic tools is well known, and large pneumatic plants have been installed in various shops and factories for the purpose of supplying the compressed air delivered to these tools as their motive power. It will, of course, be understood that such compression plants involve a duplication in so far as they require association with steam or water power, or even electrical plants, in order to compress the air or insure its storage.

Aside from the use of compressed air in drilling, excavating, building operations, mining, etc., a large capacity of such apparatus is now employed directly for manufacturing purposes. As has been pointed out by Mr. Hiscox, in his well-known treatise on the subject, the use of compressed air machinery for quarrying, mining, and drilling, and the means of compressing air economically, have been greatly extended by the inventive genius of Americans, among them Rand, Ingersoll, Sergeant, Clayton, and others. Their apparatus has contributed materially to the success of the vast system of railway tunnels all over the country, as well as to the sinking and drifting in all classes of mineral excavation during the past quarter of a century. But the use of compressed air has recently invaded the field of manufactures, and tools of this type are to be found in workshops and factories of widely dissimilar character, their portable nature rendering them extremely convenient and economical. The air hammer as a riveter and drill in shipbuilding is of universal application in the United States, and its unceasing use throughout the day produces one of the characteristic noises of American shipbuilding yards. In fact, thanks to the same appliance, it might be claimed that the modern steel building is essentially a manufactured article. The pneumatic hammer is also widely in use in application to all classes of work in the machine shops. A line of air pipe is carried along the ceiling over the vice benches with the air hose attached to a hammer, while a drill stands upon the bench ready for instant use. Another application is the pneumatic fret saw, directly attached to the piston of a pneumatic hammer, and making from 1,000 to 1,800 strokes per minute. In addition to the use of this tool in wood working establishments it may be noted that it is employed in Chicago packing houses for sawing ham bones. Its application to the manufacture of fine furniture, also, is as easy and natural as the use of the pneumatic hammer in the manufacture of sculpture. Pneumatic hoists are an important class of apparatus, used either alone or associated with cranes and travelers. The application of compressed air in the manufacture of ice might be instanced, but, like other interesting work, it lies somewhat beyond the scope of this report, as does the appliance employed for dusting purposes in machine shops and railway coaches.

RENTED POWER.

Table 11 presents the statistics with regard to rented power for each census from 1890 to 1905, to which incidental reference has already been made in discussion of various motive powers.

TABLE 11.—*Rented power, by states and territories: 1890 to 1905.*

[For 1900 the horsepower includes the hand trades and neighborhood industries, except custom gristmills, custom sawmills, and cotton ginning. Prior to 1900 the horsepower includes all hand trades and neighborhood industries.]

STATE OR TERRITORY.	HORSEPOWER.		
	1905	1900	1890
United States	632,905	319,475	88,571
Alabama	1,542	721	283
Alaska	3	.....	.....
Arizona	415	38	40
Arkansas	585	256	160
California	41,885	12,230	2,593
Colorado	3,836	1,539	276
Connecticut	14,280	9,242	3,098
Delaware	1,256	1,522	104
District of Columbia	1,004	771	51
Florida	1,000	162	13
Georgia	7,762	1,940	457
Idaho	637	6	.....
Illinois	53,519	27,096	6,753
Indian Territory	105	.....	.....
Indiana	11,049	4,444	1,678
Iowa	5,030	3,255	190
Kansas	2,840	1,583	223
Kentucky	4,365	2,440	324
Louisiana	2,851	1,593	7
Maine	10,182	8,789	2,870
Maryland	4,668	2,383	979
Massachusetts	52,638	31,994	15,307
Michigan	14,816	6,385	1,983
Minnesota	9,804	4,742	1,481
Mississippi	533	502	212
Missouri	15,295	8,923	1,597
Montana	3,906	1,259	17
Nebraska	2,491	1,217	179
Nevada	835	1	.....
New Hampshire	13,745	4,426	955
New Jersey	18,912	10,102	3,562
New Mexico	268	8	10
New York	170,895	82,539	25,723
North Carolina	2,925	1,510	87
North Dakota	287	154	27
Ohio	28,902	16,614	5,880
Oklahoma	652	65	.....
Oregon	4,805	2,561	490
Pennsylvania	59,067	38,209	6,927
Rhode Island	9,457	6,691	1,911
South Carolina	8,531	3,505	74
South Dakota	191	112	.....
Tennessee	2,657	1,894	217
Texas	4,473	2,662	124
Utah	2,941	1,603	32
Vermont	5,871	3,128	844
Virginia	4,785	1,791	193
Washington	12,409	2,738	16
West Virginia	870	285	75
Wisconsin	10,424	3,838	549
Wyoming	46	7	.....

Rented power increased from 319,475 horsepower in 1900 to 632,905 horsepower for 1905, or 98.1 per cent. The total rented power was 4.3 per cent of the power of all kinds. According to the subdivided statistics this rented power for 1905 was very largely

electrical, namely 441,592 horsepower, other rented power amounting to only 191,313 horsepower. In other words, electric power was slightly more than two-thirds of the total rented horsepower.

The rented power was concentrated in the states of dense population and industrial centers, where motive power is required in small quantities for a wide range of minor industries. This fact in itself would explain the rapid increase from 88,571 horsepower in 1890 to a capacity more than seven times as great for 1905. The introduction of electric power also contributed largely to this increase. In the large cities even the more extensive manufacturing establishments find it economical to abandon the use of steam for the purposes of motive power, and in the shape of electrical energy to rent power from the local electric light and power central stations, retaining their steam systems merely for operation at low pressure for heating purposes.

The effect of the use of electricity in reducing the amount of other kinds of rented power has already been pointed out. The various central station companies throughout the country have found in the development of this class of business a large and profitable source of income, giving them a load for their generating apparatus in the daytime and thus keeping their plant busy to very nearly its full capacity at all hours of the day and night. In the special report of the Bureau of the Census on Central Electric Light and Power Stations, in 1902, statistics were given showing that the 3,620 plants from which figures were collected, derived $14,048,458, or 16.4 per cent of their total income ($85,700,605) from electric service other than arc or incandescent lighting. This service was almost entirely of the rented electric power character in this report. Hence central station and power transmission companies during the past few years have devoted special attention to this class of business, encouraging it by low rates, liberal discounts, etc. The contract drawn up by the electric companies with their industrial customers often includes clauses to the effect that for a period of years from date the lessor agrees to furnish and the lessee to receive and pay for within the time and on the terms set forth, all the electrical energy that may be required to drive and to light his plant properly. The amount of the bill is determined by meter readings at such rates as the following: 1,800 to 2,160 kilowatt hours, at $13.50 per kilowatt hour per annum; more than 2,160 kilowatt hours and not exceeding 2,520, at the rate of $30 per kilowatt hour per annum; more than 2,520 kilowatt hours and not exceeding 2,700, at the rate of $28.50 per kilowatt hour per annum; all in excess of 2,700 kilowatt hours, at the rate of $27.50. The above rates are based on an "annum" of 3,000 hours.

It is stated that central station managers do not have much difficulty in obtaining industrial power customers up to a capacity of 10 or 15 horsepower, as the cost of running motors of this size is generally below the cost of running a small steam engine or other prime mover, when all the items that go to make up the operating cost are taken into consideration.

An interesting feature in the development of such work has been the study of the average load of electrical energy consumed as related to the capacity of motor plant installed, and reports on the subject of purchased electric power in factories in this respect have been presented to the National Electric Light Association. For example, in boiler shops throughout the country with individual motor drive and with a connected motor capacity of 161 horsepower the percentage of average load was 20.7. In foundries with a connected load of 445.5 horsepower the percentage of average load to connected load was 43.7. In a large number of general manufacturing establishments usually with group-driving of machinery, in some plants employing as many as 40 and 50 motors, the total connected motor load was 12,231.5 horsepower. The percentage of average load to connected motor load was 33.9. In ice machinery and refrigeration the percentage ran up to 53.4. Aside from the question involved as to the relative economy between individual and group-motor drive, it will be seen that the plant at the central station during the daytime could have connected to its circuits a capacity of motors far beyond its actual ability to supply, for the reason that the actual demand at any moment is so far below the consumption of which the motors are capable. On the other hand, it is to the advantage of central station companies to secure as a customer a busy machine shop rather than a dull factory, and to have at all times as large a demand as possible for its output of electrical energy.